ENERGY SAVINGS PLAN

SUBMITTED BY:
DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648
Rev 3
12/23/2022

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Lawrenceville, NJ 08648

Table of Contents

ENERGY SAVINGS PLAN

SECTION 1 – PROJECT OVERVIEW

Project Overview

The Energy Savings Plan (ESP) is the core of the Energy Savings Improvement Program (ESIP) process. It describes the Ramapo Indian Hills Regional High School District's preferred Energy Conservation Measures (ECMs), the budget cost for each ECM and the ECM energy savings calculations that self-fund the project via reduced operating costs. The ESP provides the Ramapo Indian Hills Regional High School District the necessary information to decide which proposed ECMs to implement as part of your (ESIP) project. Working with the School District's staff, your selected ESIP project would:

1. Self-fund $5,839,736 of building improvements
2. Generate $367,017 in annual energy savings – 49% of current utility spend
3. Eligible for $931,359 in rebates and incentives
4. Reduce utility related annual CO2 emissions by 2,428 metric tons – a 71% reduction

NOTE: This submitted ESP doesn't constitute any contractual obligation between the Ramapo Indian Hills Regional High School District and DCO Energy (DCO). Any contractual obligations will be performed under separate legal documents per mutual signed agreement of the parties involved and subject to the applicable laws and requirements of the ESIP legislation and State of New Jersey.

To ensure conformance with the requirements of Public Finance Notice LFN 2009-11, the ESP must address the following elements:

- *The results of the energy audit (APPENDIX H)*
- *A description of the energy conservation measures that will comprise the program; (Section 3)*
- *An estimate of greenhouse gas reductions resulting from those energy savings; (Section 3)*
- *Identification of all design and compliance issues and identification of who will provide these services; (Section 5)*
- *An assessment of risks involved in the successful implementation of the plan; (Section 5)*
- *Identify the eligibility for, and costs and revenues associated with the PJM Independent System Operator for demand response and curtailable service activities; (Section 3)*
- *Schedules showing calculations of all costs of implementing the proposed energy conservation measures and the projected energy savings; (Section 3)*

- *Maintenance requirements necessary to ensure continued energy savings, and describe how they will be provided; and (Section 6)*
- *If developed by an ESCO, a description of, and cost estimates of a proposed energy savings guarantee. (Section 7)*

In addition, and per LFN 2009-11, the ESP requires several other important elements:

- *The calculations of energy savings must be made in accordance with protocols for their calculation adopted by the BPU. The calculation shall include all applicable State and federal rebates and tax credits, but shall not include the cost of an energy audit and the cost of verifying energy savings. (Section 3)*
- *An independent third party must review the plan and certify that the plan savings were properly calculated pursuant to the BPU protocols.*
- *If an ESCO is used to prepare the plan, the ESCO must provide an estimate of the cost of a guarantee of energy savings. When adopting the plan, the local unit must decide whether or not to accept the guarantee (covered below). (Section 7)*
- *The plan must be verified by an independent third party to ensure that the calculations were made in accordance with the BPU standards and that all required elements of the ESP are covered.*
- *After verification is completed, the governing body must formally adopt the plan. At that point, the plan must be submitted to the Board of Public Utilities where it will be posted on the BPU website. BPU approval is not required. If the contracting unit maintains its own website, the plan must also be posted on that site.*

Ramapo Indian Hills BOE is utilizing a modified version of the PSEG Engineered Solutions Program as part of their ESIP energy savings plan. The investment grade audit was performed by an ESCO and reviewed by PSEG. This was the basis for the ESCO developed Energy Savings Plan that was also reviewed by PSEG to satisfy the requirements of Engineered Solutions. The ECMs within this plan are being paid as part of the ESIP financing, with PSE&G paying incentives.

DCO Energy looks forward to the third-party review of our energy calculations and the Ramapo Indian Hills Regional High School District's approval of the Energy Savings Plan to implement via the requirements of the ESIP legislation. Your time, effort, and support are appreciated.

Ramapo High School

Ramapo High School is a two-story, 241,600 square foot building originally built in 1957. The facility includes classrooms, gymnasium, auditorium, offices, cafeteria, corridors, stairwells, media center, computer room, a commercial kitchen and mechanical space. The building is in operation ten months out of the year. Occupied hours are 7:00AM to 2:45PM on weekdays, and 8:00AM to 1:00PM in specific spaces on weekends. The building is occupied by 1,100 students and about 180 staff.

Description of Building HVAC

Most classrooms are equipped with unit ventilators served by the school's hot water boiler plant. The 700 and 800 wing classrooms are served two AAON DX/Furnace rooftop units providing ventilation air to reheat boxes in each classroom. The main gym is served by two rooftop heating and ventilation units, while the auxiliary gym is served by two internal hot water air handlers. The cafeteria is served by one rooftop unit. Various spaces are served by packaged roof top units both DX Cooling Only and DX/Furnace (Cooling and Heating). The Auditorium is served by one 75-ton AAON unit, the library is served by one 25-ton Carrier unit and guidance office is served by one 8.5-ton Carrier unit, all of which are DX cooling and Gas-Fired Furnace heating.3 rooftop units serve the 900 wing classrooms, and the TV Studio and Band room are also conditioned by DX/Furnace style rooftop units.

Various spaces are conditioned by split system air conditioners and heat pumps. There are about 15 split system air conditioners all between 1 to 4 tons each. These include units manufactured by Airedale, Mitsubishi, Daiken, and Trane. Currently, about 59% of the school has cooling. The district replacing the boiler plant and system pumps at Ramapo High School during the summer of 2022. The new boilers (anticipated for September use) will be four Aerco BMK 4,000 MBh hot water condensing boilers. The boilers provide hot water perimeter heating to fin tube radiators and unit ventilators throughout the building. The new hot water loop pumps will be two 60HP and two 15HP (one set for each both hot water loops) and will be equipped with variable frequency drives. Hot water is produced two 199 MBh A.O Smith domestic hot water heaters.

Description of Building Lighting

Lighting at the facility is provided mostly by 32-Watt linear fluorescent T8 lamps with electronic ballasts as well as some U-shaped fluorescent lamps, compact fluorescent lamps (CFL), linear T5 fluorescent lamps, T12 linear fluorescent lamps, LED linear and screw-in lamps and high intensity discharge (HID) fixtures. Most of the fixtures are 1, 2 or 3-lamp, 4-foot-long troffers with diffusers.

A small area of the building including library, hallways and classrooms are primarily lit with screw-in and 4-pin base CFL lamps in recessed can ceiling fixtures. Parts of the gym, cafeteria, and a few offices and classrooms have been retrofitted with LED linear tubes and fixtures. Service spaces, including restrooms and storage spaces are lit with various linear fluorescent T8 and U-bend T8 lamps in troffer fixtures, and CFL, incandescent and LED lamps in recessed can ceiling fixtures. Exit signs in the building are a mixture of fluorescent and LED fixtures. Lighting is controlled by wall switches in most spaces and is turned on during operating hours of the building. Some lighting fixtures, primarily LEDs, are fitted with occupancy sensors. The building’s exterior lighting consists mainly of wall-mounted fixtures and few parking lot pole fixtures. Sources include high pressure sodium (HPS) fixtures, metal halide (MH) fixtures, LED wall packs and CFL screw-in lamps. All exterior lighting is controlled by daylight sensors.

Indian Hills High School

Indian Hills High School is a 240,320 square foot two-story facility comprised of classrooms, offices, indoor gymnasium, locker rooms, kitchen, auditorium, and cafeteria. The building is in operation ten months out of the year. Occupied hours are 7:00 AM to 2:45 PM on weekdays, 8:00AM to 1:00PM in specific locations on weekends. The building is closed on Sundays. The building is occupied by 1100 students and about 180 staff.

Description of Building HVAC

Most classrooms are equipped with unit ventilators served by the school's hot water boiler plant. The 200 wing classrooms are served two AAON DX/Furnace rooftop units providing ventilation air to variable air volume boxes in each classroom. The Board of Education offices are also conditioned by two AAON DX/Furnace rooftop units serving zonal variable air volume boxes. The main gym is served one internal hot water air handler, while the auxiliary gym is served by one gas-fired rooftop heating and ventilation unit. The cafeteria area is served by three internal hot water air handlers, while the auditorium area is served by two internal hot water air handlers each with a split system condensing unit equaling 35 tons.

Various spaces are served by packaged roof top units both DX Cooling Only and DX/Furnace (Cooling and Heating). The library is served by one 25-ton Carrier unit and multi-media is served by one 12.5-ton Carrier unit, all of which are DX cooling. The nurse's office, conference room, child study team, faculty lounge and main office are each served by their own DX/Furnace rooftop unit. The music room and weight room are each served by a Daiken rooftop heating and ventilation units. Spaces in the 700 and 800 wings are also served by DX/Furnace style rooftop units both manufactured by Carrier and AAON. Various spaces are also conditioned by split system air conditioners and heat pumps. There are about 18 split system air conditioners all between 1 to 4 tons each. These include units manufactured by Airedale, Mitsubishi, Daiken, and Carrier. Currently, about 50% of the school has cooling. The existing boiler plant consists of six Aerco BMK 3,000 MBh hot water condensing boilers. The boilers provide hot water perimeter heating to fin tube radiators and unit ventilators throughout the building. The hot water loop is served by four 25HP pumps equipped with variable frequency drives. Hot water is produced three 399 MBh Laars domestic hot water heaters.

Description of Building Lighting

Lighting at the facility is provided mostly by 32-Watt linear fluorescent T8 lamps with electronic ballasts as well as some U-shaped fluorescent lamps, compact fluorescent lamps (CFL), linear T5 fluorescent lamps, LED linear and screw-in lamps and high intensity discharge (HID) fixtures. Most of the fixtures are 1, 2 or 3-lamp, 4-foot-long troffers with diffusers. The interior HID lighting is mostly in gymnasiums, fitness room and auditorium areas.

Service spaces, including restrooms and storage spaces are primarily lit with fluorescent linear T8 lamps in troffer fixtures, CFL and LED lamps in recessed can ceiling fixtures. Exit signs in the building are a mixture of incandescent lamp fixtures and LED fixtures. Lighting is controlled by wall switches in most spaces and is turned on during operating hours of the building. In some spaces of the building, lighting fixtures (mostly LEDs) are fitted with occupancy sensors. The building's exterior lighting is consisting mainly of wall mounted fixtures and few parking lot pole fixtures. Sources include high pressure sodium (HPS) fixtures, metal halide (MH) fixtures, LED wall packs and CFL screw-in lamps. All exterior lighting is controlled by daylight sensors.
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ENERGY SAVINGS PLAN

SECTION 2 – ENERGY BASELINE

Total Utility Consumption and Site EUI

The Ramapo Indian Hills Regional High School District Energy Savings Plan includes 2 buildings, both high schools. To develop the ESP, DCO Energy was provided with all available utility data (electric, natural gas, water/sewer). DCO Energy tracked and documented this utility data from December of 2020 through December of 2021. A listing of the buildings, the total utility consumption, and Energy Usage Index for the 2 sites are detailed below.

BUILDINGS & FACILITIES		
BUILDING #	BUILDING/FACILITY NAME	SQFT
1	**Ramapo High School**	**241,600**
2	**Indian Hills High School**	**240,320**

Ramapo Indian Hills RHSD - Energy Use Summary

RAMAPO INDIAN HILLS RHSD BUILDINGS/FACILITIES		ELECTRIC				
BUILDING/FACILITY NAME	SQFT	USAGE kWh	DEMAND kW	USAGE BTU / SQFT	TOTAL COST $$	BLENDED COST $$ / kWh
Ramapo Regional High School	241,600	2,232,867	700	31,534	$278,096	$0.125
Indian Hills Regional High School	240,320	2,102,051	732	29,844	$260,981	$0.124
TOTALS	**481,920**	**4,334,918**	**1,433**	**30,691**	**$539,078**	**$0.124**

RAMAPO INDIAN HILLS RHSD BUILDINGS/FACILITIES		NATURAL GAS			
BUILDING/FACILITY NAME	SQFT	USAGE THERMS	USAGE BTU / SQFT	TOTAL COST $$	BLENDED COST $$ / THERM
Ramapo Regional High School	241,600	120,463	49,861	$98,207	$0.815
Indian Hills Regional High School	240,320	119,571	49,755	$89,443	$0.748
TOTALS	**481,920**	**240,034**	**49,808**	**$187,651**	**$0.782**

RAMAPO INDIAN HILLS RHSD BUILDINGS/FACILITIES		Water & Sewer (Gal)			
BUILDING/FACILITY NAME	SQFT	USAGE Water & Sewer (Gal)	USAGE GAL / SQFT	TOTAL COST $$	UNIT COST $$ / Water & Sewer (Gal)
Ramapo Regional High School	241,600	1,536,000	6.36	$19,523	$0.0127
Indian Hills Regional High School	240,320	1,184,000	4.93	$8,556	$0.0072
TOTALS	**481,920**	**2,720,000**	**5.64**	**$28,079**	**$0.0103**

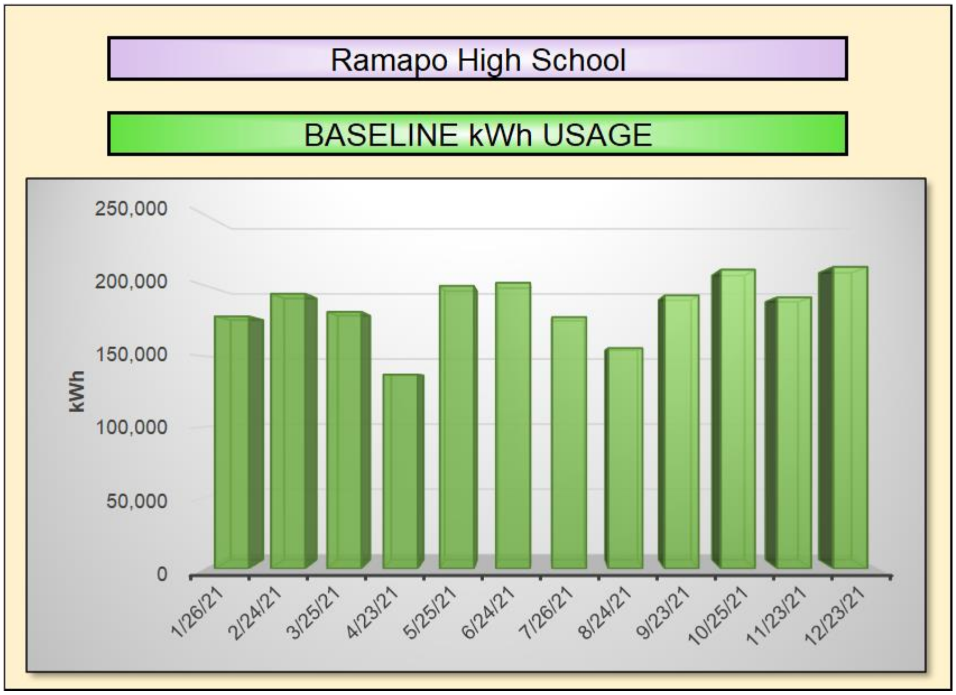
RAMAPO INDIAN HILLS RHSD BUILDINGS/FACILITIES		SITE ENERGY	SOURCE ENERGY	TOTAL COST
BUILDING/FACILITY NAME	SQFT	USAGE BTUs	USAGE BTUs	$$
Ramapo Regional High School	241,600	19,664,872,904	33,980,565,406	$395,827
Indian Hills Regional High School	240,320	19,129,288,612	32,637,099,564	$358,980
TOTALS	**481,920**	**38,794,161,516**	**66,617,664,970**	**$754,807**

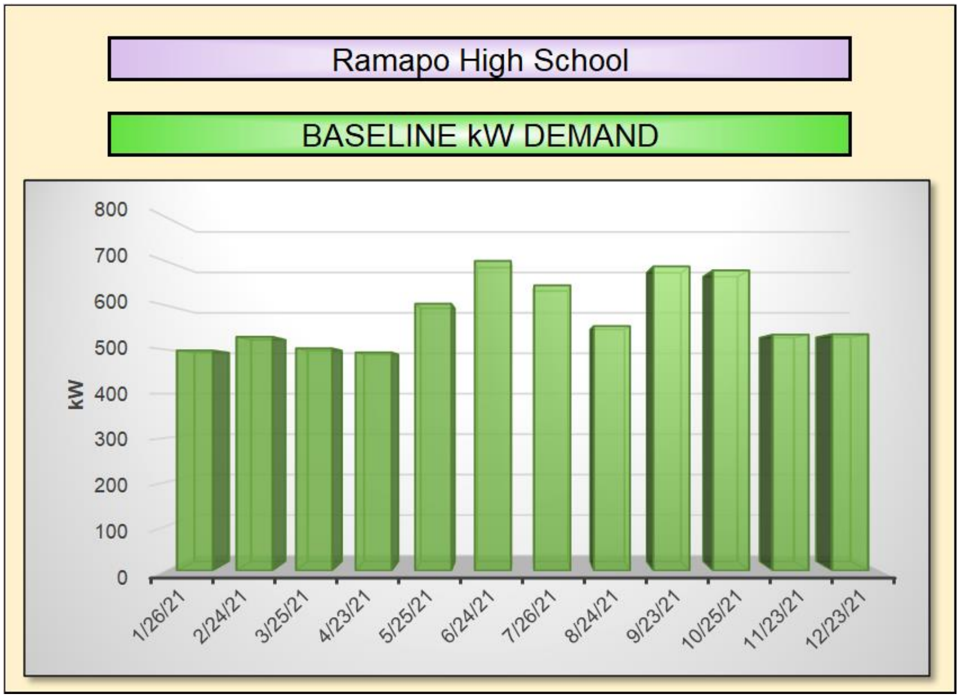
Ramapo Indian Hills RHSD – Energy Use & Cost Index

RAMAPO INDIAN HILLS RHSD BUILDINGS/FACILITIES		SITE EUI		
BUILDING/FACILITY NAME	SQFT	USAGE BTU / SQFT	NATIONAL MEDIAN BTU / SQFT	NATIONAL MEDIAN +/- %
Ramapo Regional High School	241,600	81,394	68,800	-18%
Indian Hills Regional High School	240,320	79,599	68,800	-16%
TOTALS	**481,920**	**80,499**	**68,800**	**-17%**

RAMAPO INDIAN HILLS RHSD BUILDINGS/FACILITIES		SITE ECI		
BUILDING/FACILITY NAME	SQFT	COST $$ / SQFT	NATIONAL MEDIAN $$ / SQFT	NATIONAL MEDIAN +/- %
Ramapo Regional High School	241,600	$1.64	$1.38	-19%
Indian Hills Regional High School	240,320	$1.49	$1.38	-8%
TOTALS	**481,920**	**$1.57**	**$1.38**	**-14%**

Ramapo High School Baseline Energy Use





Ramapo High School								ELECTRIC METER #1				
Provider:	Rockland Electric Company		Account #:	58787-51006				Meter #:	601448348			
Commodity:	Mid American Energy Services		Commodity:	Electric				Rate Tariff:	701106908			
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Customer Charge	Electric Demand Charges	Total Electric Charges	Marginal Rate $/kWh	Days	Load Factor	BTU
12/23/20	1/26/21	170,407	491	$4,213	$11,902	$92	$3,465	$19,672	$0.095	35	41%	581,428,684
1/27/21	2/24/21	187,489	522	$4,629	$13,393	$92	$3,683	$21,796	$0.096	29	52%	639,712,468
2/25/21	3/25/21	175,293	496	$4,138	$12,542	$92	$3,499	$20,271	$0.095	29	51%	598,099,716
3/26/21	4/23/21	128,652	486	$3,015	$9,205	$92	$3,433	$15,745	$0.095	29	38%	438,960,624
4/24/21	5/25/21	188,568	595	$4,418	$13,492	$92	$4,201	$22,203	$0.095	32	41%	643,394,016
5/26/21	6/24/21	193,606	692	$4,536	$13,852	$92	$5,544	$24,025	$0.095	30	39%	660,583,672
6/25/21	7/26/21	171,683	639	$4,459	$12,284	$92	$5,271	$22,106	$0.098	32	35%	585,782,396
7/27/21	8/24/21	148,414	544	$3,942	$10,619	$92	$4,488	$19,141	$0.098	29	39%	506,388,568
8/25/21	9/23/21	180,038	675	$4,782	$12,882	$92	$5,567	$23,323	$0.098	30	37%	614,289,656
9/24/21	10/25/21	195,653	663	$5,338	$13,999	$92	$4,853	$24,282	$0.099	32	38%	667,568,036
10/26/21	11/23/21	175,597	516	$4,827	$12,564	$92	$3,643	$21,126	$0.099	29	49%	599,136,964
11/24/21	12/23/21	201,443	523	$5,537	$14,413	$92	$3,695	$23,737	$0.099	30	53%	687,323,516
TOTALS		2,116,843	692	$53,834	$151,147	$1,104	$51,341	$257,426	$0.097	366	35%	7,222,668,316

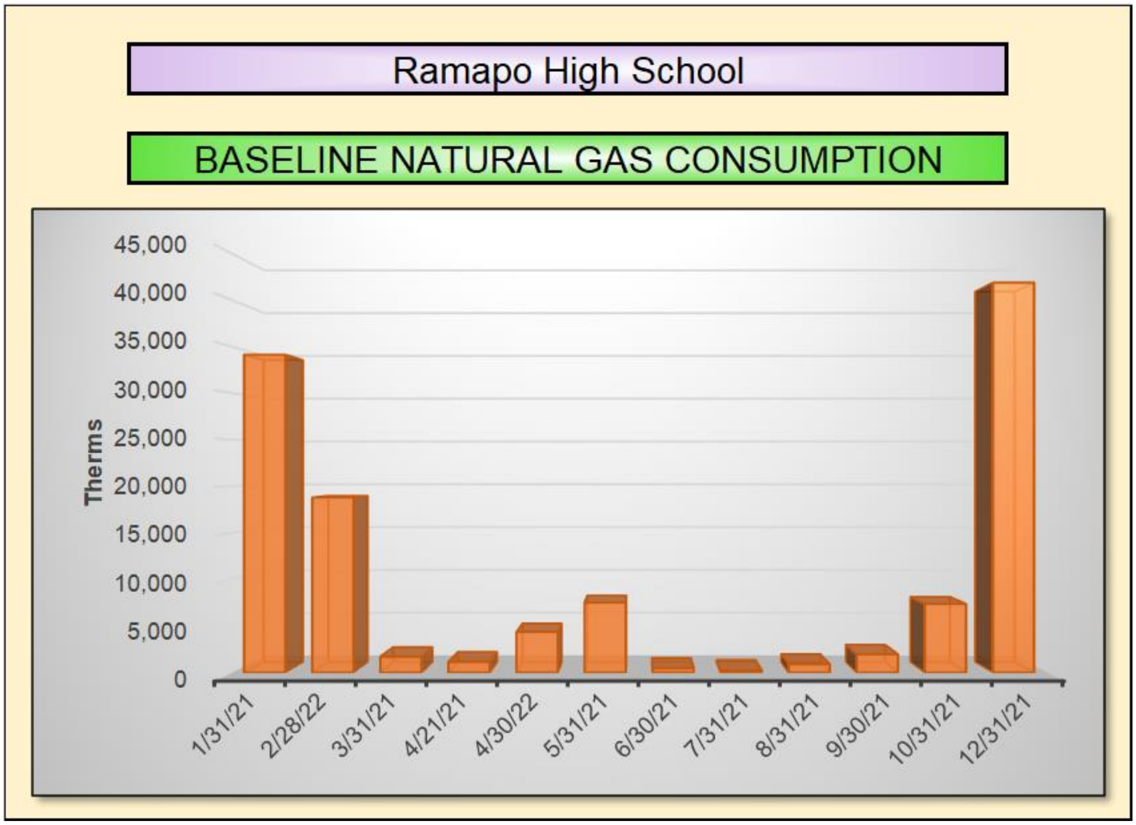
Ramapo High School								ELECTRIC METER #2				
Provider:	Rockland Electric Company		Account #	50387-51008				Meter #	701012632			
Commodity:	Mid American Energy Services		Account #	Electric				Meter #				
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Customer Charge	Electric Demand Charges	Total Electric Charges	Marginal Rate $/kWh	Days	Load Factor	BTU
12/20/20	1/26/21	608	0	$48	$31	$14	$0	$93	$0.129	38	0%	2,074,496
1/27/21	2/24/21	733	0	$58	$37	$14	$0	$109	$0.129	29	0%	2,500,996
2/25/21	3/25/21	504	0	$35	$22	$14	$0	$71	$0.113	29	0%	1,719,648
3/26/21	4/23/21	3,521	0	$244	$155	$14	$0	$413	$0.113	29	0%	12,013,652
4/24/21	5/25/21	5,824	0	$404	$256	$14	$0	$674	$0.113	32	0%	19,871,488
5/26/21	6/24/21	3,376	0	$318	$202	$14	$0	$534	$0.154	30	0%	11,518,912
6/25/21	7/26/21	823	0	$80	$50	$14	$0	$144	$0.158	32	0%	2,808,076
7/27/21	8/24/21	2,191	0	$213	$135	$14	$0	$362	$0.159	29	0%	7,475,692
8/25/21	9/23/21	7,220	0	$633	$402	$14	$0	$1,049	$0.143	30	0%	24,634,640
9/24/21	10/25/21	9,062	0	$789	$500	$14	$0	$1,304	$0.142	32	0%	30,919,544
10/26/21	11/23/21	9,545	0	$830	$526	$14	$0	$1,369	$0.142	29	0%	32,567,540
11/24/21	12/27/21	4,316	0	$310	$197	$14	$0	$521	$0.117	34	0%	14,726,192
TOTALS		47,723	0	$3,962	$2,512	$168	$0	$6,642	$0.136	373	0%	162,830,876

Ramapo High School									ELECTRIC METER #3			
Provider:	Rockland Electric Company			Account #	25376-47002				Meter #	Electric C&I		
Commodity:	Mid American Energy Services			Account #	Electric				Meter #			
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Customer Charge	Electric Demand Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/21/20	1/22/21	1,151	0	$83	$105	$134	$0	$322	$0.164	33	$0.00	3,927,212
1/23/21	2/22/21	1,051	0	$76	$70	$134	$0	$280	$0.138	31	$0.00	3,586,012
2/23/21	3/22/21	853	0	$48	$57	$134	$0	$239	$0.123	28	$0.00	2,910,436
3/23/21	4/20/21	786	0	$44	$63	$134	$0	$241	$0.136	29	$0.00	2,681,832
4/21/21	5/20/21	719	0	$40	$40	$134	$0	$215	$0.112	30	$0.00	2,453,228
5/21/21	6/21/21	702	0	$67	$50	$134	$0	$251	$0.166	32	$0.00	2,395,224
6/22/21	7/21/21	658	0	$66	$44	$134	$0	$244	$0.167	30	$0.00	2,245,096
7/22/21	8/20/21	716	0	$73	$47	$134	$0	$254	$0.168	30	$0.00	2,442,992
8/21/21	9/21/21	864	0	$74	$53	$134	$0	$262	$0.148	32	$0.00	2,947,968
9/22/21	10/21/21	922	0	$79	$60	$134	$0	$273	$0.150	30	$0.00	3,145,864
10/22/21	11/19/21	981	0	$83	$49	$134	$0	$266	$0.135	29	$0.00	3,347,172
11/20/21	12/21/21	1,151	0	$69	$62	$134	$0	$265	$0.114	32	$0.00	3,927,212
TOTALS		10,554	0	$802	$700	$1,609	$0	$3,111	$0.142	366	$0.00	36,010,248

Ramapo High School									ELECTRIC METER #4			
Provider:	Rockland Electric Company			Account #	25586-47002				Meter #	Electric C&I - Overhead Lighting		
Commodity:	Mid American Energy Services			Account #					Meter #			
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Customer Charge	Electric Demand Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/23/20	1/26/21	3,301	0	$72	$166	$373	$0	$611	$0.072	35	$0.00	11,263,012
1/27/21	2/24/21	2,638	0	$58	$132	$373	$0	$563	$0.072	29	$0.00	9,000,856
2/25/21	3/25/21	2,368	0	$40	$93	$373	$0	$506	$0.056	29	$0.00	8,079,616
3/26/21	4/22/21	2,024	0	$34	$79	$373	$0	$486	$0.056	28	$0.00	6,905,888
4/23/21	5/25/21	2,115	0	$36	$83	$373	$0	$491	$0.056	33	$0.00	7,216,380
5/26/21	6/24/21	1,760	0	$52	$119	$373	$0	$543	$0.097	30	$0.00	6,005,120
6/25/21	7/26/21	1,906	0	$58	$134	$373	$0	$565	$0.101	32	$0.00	6,503,272
7/27/21	8/24/21	1,906	0	$59	$135	$373	$0	$566	$0.101	29	$0.00	6,503,272
8/25/21	9/23/21	2,220	0	$58	$133	$373	$0	$564	$0.086	30	$0.00	7,574,640
9/24/21	10/25/21	2,682	0	$69	$159	$373	$0	$601	$0.085	32	$0.00	9,150,984
10/26/21	11/23/21	2,688	0	$69	$159	$373	$0	$600	$0.085	29	$0.00	9,171,456
11/24/21	12/23/21	2,933	0	$54	$123	$373	$0	$549	$0.060	30	$0.00	10,007,396
TOTALS		28,541	0	$660	$1,513	$4,471	$0	$6,644	$0.076	366	$0.00	97,381,892

Ramapo High School								ELECTRIC METER #5				
Provider:	Rockland Electric Company			Account #	50177-51008				Meter #	701224025		
Commodity:	Mid American Energy Services			Account #					Meter #			
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Customer Charge	Electric Demand Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/23/20	1/26/21	1,958	4	$79	$137	$21	$13	$250	$0.110	35	57%	6,680,696
1/27/21	2/24/21	1,625	4	$66	$116	$21	$13	$216	$0.112	29	58%	5,544,500
2/25/21	3/25/21	1,707	4	$67	$122	$21	$13	$224	$0.111	29	59%	5,824,284
3/26/21	4/23/21	1,535	4	$60	$110	$21	$13	$204	$0.111	29	54%	5,237,420
4/24/21	5/25/21	1,753	4	$69	$125	$21	$13	$228	$0.111	32	56%	5,981,236
5/26/21	6/24/21	1,770	4	$72	$127	$21	$16	$235	$0.112	30	59%	6,039,240
6/25/21	7/25/21	1,877	5	$82	$134	$21	$18	$255	$0.115	31	53%	6,404,324
7/26/21	8/24/21	1,786	5	$79	$128	$21	$18	$246	$0.116	30	52%	6,093,832
8/25/21	9/23/21	1,887	12	$84	$135	$21	$61	$301	$0.116	30	22%	6,438,444
9/24/21	10/25/21	2,002	13	$87	$143	$21	$59	$311	$0.115	32	20%	6,830,824
10/26/21	11/23/21	2,006	15	$87	$144	$21	$66	$317	$0.115	29	20%	6,844,472
11/24/21	12/27/21	2,384	8	$103	$171	$21	$33	$328	$0.115	34	35%	8,134,208
TOTALS		22,290	15	$936	$1,591	$252	$335	$3,115	$0.113	370	17%	76,053,480

Ramapo High School								ELECTRIC METER #6				
Provider:	Rockland Electric Company			Account #	01611-23002				Meter #	701283569		
Commodity:	Mid American Energy Services			Account #					Meter #			
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Customer Charge	Electric Demand Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/23/20	1/26/21	579	3	$24	$40	$21	$10	$95	$0.110	35	22%	1,975,548
1/27/21	2/24/21	479	3	$19	$34	$21	$10	$85	$0.112	29	22%	1,634,348
2/25/21	3/25/21	493	3	$19	$35	$21	$10	$86	$0.111	29	23%	1,682,116
3/26/21	4/23/21	499	3	$20	$36	$21	$10	$86	$0.111	29	23%	1,702,588
4/24/21	5/25/21	553	5	$22	$40	$21	$14	$97	$0.111	32	16%	1,886,836
5/26/21	6/24/21	536	4	$22	$38	$21	$15	$96	$0.112	30	18%	1,828,832
6/25/21	7/25/21	570	1	$25	$41	$21	$4	$91	$0.115	31	66%	1,944,840
7/26/21	8/24/21	603	4	$27	$43	$21	$16	$107	$0.116	30	20%	2,057,436
8/25/21	9/23/21	567	1	$25	$41	$21	$4	$91	$0.116	30	69%	1,934,604
9/24/21	10/25/21	667	3	$29	$48	$21	$10	$108	$0.115	32	30%	2,275,804
10/26/21	11/23/21	627	3	$27	$45	$21	$9	$102	$0.115	29	31%	2,139,324
11/24/21	12/27/21	743	3	$32	$53	$21	$9	$116	$0.115	34	31%	2,535,116
TOTALS		6,916	5	$291	$494	$252	$122	$1,158	$0.113	370	17%	23,597,392



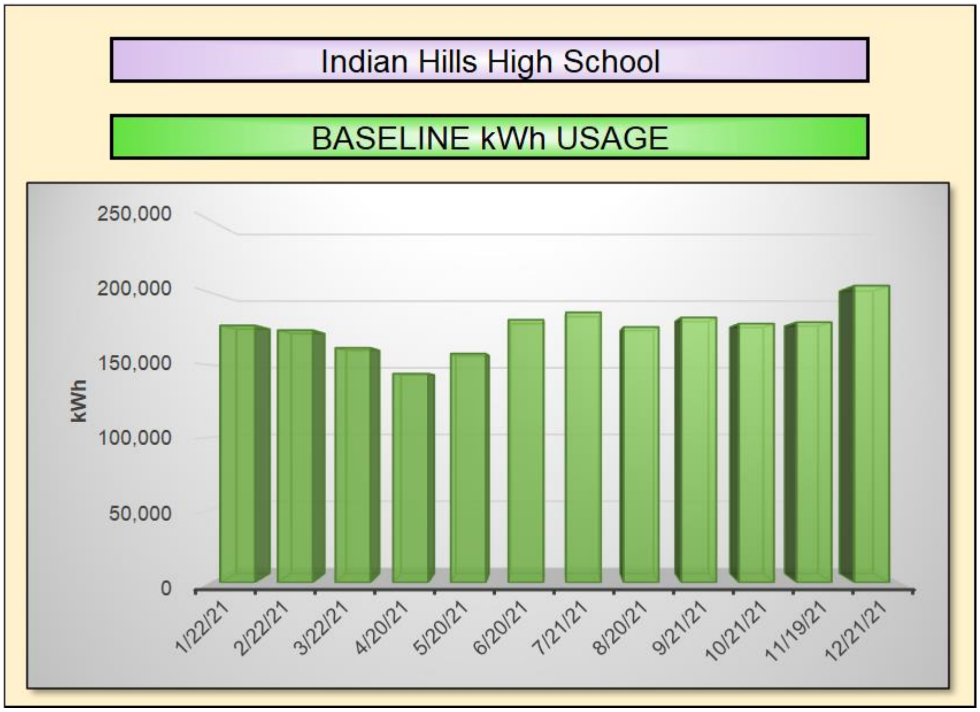
Ramapo High School							Natural Gas Meter #1		
Provider	PSEG		Account #	4200001705				Meter #	3010541/1810129
Commodity			Commodity					Rate Tariff:	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Customer Charge	Gas Demand Charge	Gas Commodity Charges	Gas Total Charges	$/Therm Marginal Rate	BTU
1/1/21	1/31/21	31,019	$4,436	$153	$4,256	$13,481	$22,326	$0.71	3,101,896,600
2/1/21	2/28/22	15,755	$2,335	$153	$4,256	$6,861	$13,604	$0.85	1,575,473,600
3/1/22	3/31/21	0	$0	$153	$4,256	$0	$4,409	-	0
4/1/21	4/21/21	0	$0	$107	$0	$0	$107	-	0
4/22/21	4/30/22	3,362	$498	$46	$0	$1,467	$2,010	$0.58	336,186,500
5/1/22	5/31/21	6,896	$1,018	$153	$0	$3,009	$4,179	$0.58	689,573,000
6/1/21	6/30/21	1	$0	$158	$0	$0	$158	$0.49	103,100
7/1/21	7/31/21	0	$0	$158	$0	$0	$158	-	0
8/1/21	8/31/21	0	$0	$158	$0	$0	$158	-	0
9/1/21	9/30/21	11	$1	$158	$0	$5	$163	$0.50	1,144,600
10/1/21	10/31/21	4,928	$781	$158	$0	$2,152	$3,090	$0.60	492,778,500
11/1/21	12/31/21	39,265	$6,438	$322	$8,772	$17,047	$32,579	$0.82	3,926,532,300
TOTALS		101,237	$15,506	$1,873	$21,541	$44,021	$82,941	$0.80	10,123,688,200

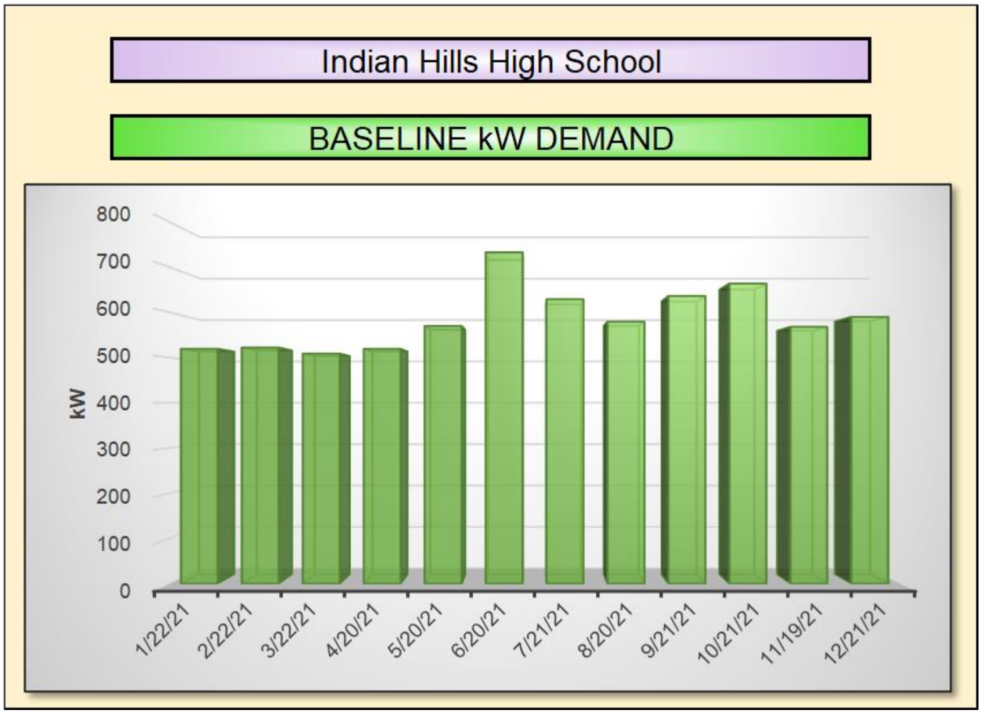
Ramapo High School							Natural Gas Meter #2		
Provider	PSEG		Account #	6712460204				Meter #	4018806
Commodity			Commodity					Rate Tariff	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Customer Charge	Gas Demand Charge	Gas Commodity Charges	Gas Total Charges	Cost / Unit Checksum	BTU
1/6/21	2/4/21	2,507	$296	$153	$356	$1,092	$1,896	$0.55	250,747,100
2/5/21	3/8/21	2,478	$299	$153	$356	$1,079	$1,886	$0.56	247,797,700
3/9/21	4/7/21	1,519	$161	$153	$0	$661	$975	$0.54	151,868,900
4/8/21	5/6/21	1,138	$107	$153	$0	$495	$755	$0.53	113,763,200
5/7/21	6/7/21	1,006	$67	$154	$0	$438	$659	$0.50	100,608,400
6/8/21	7/7/21	625	$41	$158	$0	$272	$470	$0.50	62,505,100
7/8/21	8/5/21	474	$31	$158	$0	$206	$394	$0.50	47,356,500
8/6/21	9/3/21	252	$16	$158	$0	$110	$283	$0.50	25,158,700
9/4/21	10/5/21	905	$85	$158	$0	$394	$637	$0.53	90,460,100
10/6/21	11/3/21	1,952	$262	$158	$362	$850	$1,631	$0.57	195,200,400
11/4/21	12/6/21	2,233	$302	$159	$364	$973	$1,797	$0.57	223,349,900
12/7/21	1/6/22	2,236	$317	$164	$371	$973	$1,825	$0.58	223,563,200
TOTALS		17,324	$1,983	$1,875	$1,808	$7,543	$13,209	$0.55	1,732,379,200

Ramapo High School									
Provider	PSEG		Account #			6551615007		Meter #	3238670
Commodity			Account #					Meter #	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Customer Charge	Gas Demand Charge	Gas Commodity Charges	Gas Total Charges	Cost / Unit Checksum	BTU
1/6/21	2/4/21	573	$219	$17	$0	$291	$527	$0.92	57,293,900
2/5/21	3/8/21	554	$214	$17	$0	$297	$529	$0.95	55,410,600
3/9/21	4/7/21	185	$71	$17	$0	$99	$187	$1.01	18,470,200
4/8/21	5/6/21	28	$11	$17	$0	$15	$42	$1.50	2,833,500
5/7/21	6/7/21	10	$3	$17	$0	$6	$26	$2.51	1,047,400
6/8/21	7/7/21	0	$0	$18	$0	$0	$18	$0.00	0
7/8/21	8/5/21	0	$0	$18	$0	$0	$18	$0.00	0
8/6/21	9/3/21	0	$0	$18	$0	$0	$18	$0.00	0
9/4/21	10/5/21	4	$1	$18	$0	$3	$22	$5.33	418,600
10/6/21	11/3/21	10	$4	$18	$0	$9	$31	$2.95	1,045,400
11/4/21	12/6/21	217	$89	$18	$0	$194	$301	$1.39	21,681,100
12/7/21	1/6/22	321	$136	$19	$0	$185	$340	$1.06	32,062,600
TOTALS		1903	$747	$211	$0	$1,100	$2,058	$1.08	190,263,300

Ramapo High School							
Provider	Ridgewood Water			Water & Sewer (Gal)			
Acct #	216723-1						
Billing Period Start Date	Actual Reading	Water & Sewer (Gal)	Fixed Charges	Usage Charges	Total Charges	Cost / Unit Checksum	BTU
12/14/20	3/15/21	256,000	$1,016	$2,595	$3,610	$0.0101	0
3/16/21	6/14/21	366,000	$1,016	$3,704	$4,720	$0.0101	0
6/15/21	9/12/21	279,000	$752	$2,845	$3,597	$0.0102	0
9/13/21	12/13/21	635,000	$1,075	$6,521	$7,596	$0.0103	0
TOTALS		1,536,000	$3,858	$15,665	$19,523	$0.0102	0

Indian Hills High School Baseline Energy Use





Indian Hills High School							ELECTRIC METER #1					
Provider:	Rockland Electric Company			Account #	52119-59013				Meter #	603079380		
Commodity:	Mid American Energy Services			Commodity:	Electric				Rate Tariff:	701106894		
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Customer Charge	Electric Demand Charges	Total Electric Charges	Marginal Rate $/kWh	Days	Load Factor	BTU
12/21/20	1/22/21	160,999	432	$3,983	$11,245	$92	$3,053	$18,372	$0.095	33	47%	549,328,588
1/23/21	2/22/21	158,737	436	$3,919	$11,305	$92	$3,075	$18,391	$0.096	31	49%	541,610,644
2/23/21	3/22/21	149,334	423	$3,539	$10,685	$92	$2,985	$17,301	$0.095	28	53%	509,527,608
3/23/21	4/20/21	131,999	410	$3,093	$9,444	$92	$2,897	$15,527	$0.095	29	46%	450,380,588
4/21/21	5/20/21	144,404	465	$3,384	$10,332	$92	$3,281	$17,089	$0.095	30	43%	492,706,448
5/21/21	6/20/21	170,942	636	$4,005	$12,231	$92	$4,984	$21,312	$0.095	31	36%	583,254,104
6/21/21	7/21/21	178,015	532	$4,529	$12,737	$95	$4,549	$21,910	$0.097	31	45%	607,387,180
7/22/21	8/20/21	166,950	483	$4,408	$11,945	$92	$3,985	$20,430	$0.098	30	48%	569,633,400
8/21/21	9/21/21	169,750	539	$4,482	$12,146	$92	$4,447	$21,166	$0.098	32	41%	579,187,000
9/22/21	10/21/21	163,800	564	$4,431	$11,720	$92	$4,181	$20,424	$0.099	30	40%	558,885,600
10/22/21	11/19/21	164,150	462	$4,486	$11,745	$92	$3,262	$19,584	$0.099	29	51%	560,079,800
11/20/21	12/21/21	190,050	487	$5,194	$13,598	$92	$3,435	$22,318	$0.099	32	51%	648,450,600
TOTALS		1,949,130	636	$49,451	$139,133	$1,107	$44,134	$233,824	$0.097	366	35%	6,650,431,560

Indian Hills High School							ELECTRIC METER #2					
Provider:	Rockland Electric Company			Account #	52119-59013				Meter #	Electric C&I - Overhead Lighting		
Commodity:	Mid American Energy Services			Commodity					Rate Tariff			
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Customer Charge	Electric Demand Charges	Total Electric Charges	Marginal Rate $/kWh	Days	Load Factor	BTU
12/22/20	1/25/21	2,618	0	$57	$131	$298	$0	$486	$0.072	35	0%	8,932,616
1/26/21	2/23/21	2,097	0	$46	$105	$298	$0	$449	$0.072	29	0%	7,154,964
2/24/21	3/23/21	1,821	0	$31	$71	$298	$0	$400	$0.056	28	0%	6,213,252
3/24/21	4/21/21	1,676	0	$29	$65	$298	$0	$392	$0.056	29	0%	5,718,512
4/22/21	5/21/21	1,537	0	$26	$60	$298	$0	$384	$0.056	30	0%	5,244,244
5/22/21	6/21/21	1,454	0	$43	$97	$298	$0	$437	$0.096	31	0%	4,961,048
6/22/21	7/22/21	1,459	0	$45	$102	$298	$0	$444	$0.101	31	0%	4,978,108
7/23/21	8/20/21	1,487	0	$46	$105	$298	$0	$448	$0.101	29	0%	5,073,644
8/21/21	9/21/21	1,850	0	$49	$110	$298	$0	$457	$0.086	32	0%	6,312,200
9/22/21	10/21/21	1,974	0	$52	$117	$298	$0	$466	$0.085	30	0%	6,735,288
10/22/21	11/19/21	2,104	0	$55	$124	$298	$0	$476	$0.085	29	0%	7,178,848
11/20/21	12/21/21	2,471	0	$46	$103	$298	$0	$446	$0.060	32	0%	8,431,052
TOTALS		22,548	0	$525	$1,188	$3,571	$0	$5,285	$0.076	365	0%	76,933,776

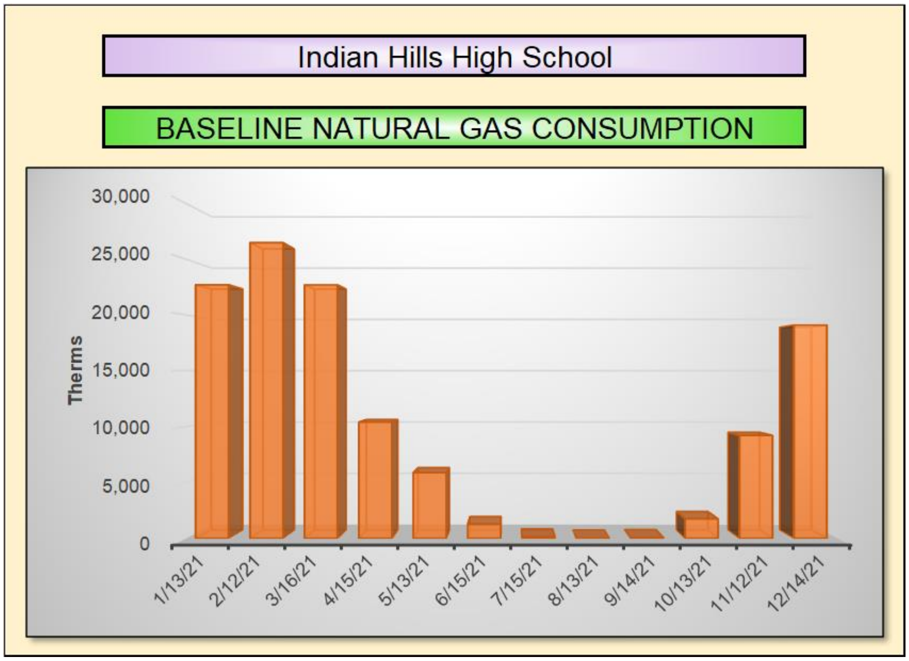
Indian Hills High School								ELECTRIC METER #3				
Provider:	Rockland Electric Company			Account #	07411-50005				Meter #	701142811		
Commodity:	Mid American Energy Services			Commodity	Electric				Rate Tariff			
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Customer Charge	Electric Demand Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/21/20	1/22/21	460	62	$19	$32	$21	$307	$379	$0.110	33	1%	1,569,520
1/23/21	2/22/21	433	62	$18	$31	$21	$307	$377	$0.112	31	1%	1,477,396
2/23/21	3/22/21	373	62	$15	$27	$21	$307	$370	$0.111	28	1%	1,272,676
3/23/21	4/20/21	3,646	86	$143	$261	$21	$431	$856	$0.111	29	6%	12,440,152
4/21/21	5/20/21	6,266	86	$242	$448	$21	$430	$1,141	$0.110	30	10%	21,379,592
5/21/21	6/21/21	2,966	84	$120	$212	$21	$470	$823	$0.112	32	5%	10,119,992
6/22/21	7/21/21	1,470	84	$64	$105	$21	$495	$685	$0.115	30	2%	5,015,640
7/22/21	8/20/21	2,449	83	$108	$175	$21	$490	$795	$0.116	30	4%	8,355,988
8/21/21	9/21/21	5,552	83	$243	$397	$21	$494	$1,156	$0.115	32	9%	18,943,424
9/22/21	10/21/21	7,497	83	$319	$536	$21	$438	$1,314	$0.114	30	13%	25,579,764
10/22/21	11/19/21	7,564	84	$320	$541	$21	$418	$1,300	$0.114	29	13%	25,808,368
11/20/21	12/21/21	2,617	83	$113	$187	$21	$415	$737	$0.115	32	4%	8,929,204
TOTALS		41,293	86	$1,724	$2,954	$252	$5,002	$9,932	$0.113	366	5%	140,891,716

Indian Hills High School								ELECTRIC METER #4				
Provider:	Rockland Electric Company			Account #	04681-40007				Meter #	701122615		
Commodity:	Mid American Energy Services			Commodity					Rate Tariff			
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Customer Charge	Electric Demand Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/20/20	1/22/21	6,498	12	$259	$454	$21	$53	$787	$0.110	34	65%	22,171,176
1/23/21	2/22/21	6,232	11	$249	$444	$21	$48	$762	$0.111	31	74%	21,263,584
2/23/21	3/22/21	5,241	12	$206	$375	$21	$52	$655	$0.111	28	64%	17,882,292
3/23/21	4/20/21	4,657	11	$183	$333	$21	$49	$586	$0.111	29	59%	15,889,684
4/21/21	5/20/21	4,251	10	$167	$304	$21	$43	$535	$0.111	30	57%	14,504,412
5/21/21	6/21/21	4,252	7	$172	$304	$21	$31	$528	$0.112	32	76%	14,507,824
6/22/21	7/21/21	3,845	7	$167	$275	$21	$31	$494	$0.115	30	76%	13,119,140
7/22/21	8/20/21	3,663	8	$162	$262	$21	$36	$481	$0.116	30	66%	12,498,156
8/21/21	9/21/21	3,803	7	$168	$272	$21	$33	$495	$0.116	32	67%	12,975,836
9/22/21	10/21/21	3,407	7	$149	$244	$21	$27	$440	$0.115	30	69%	11,624,684
10/22/21	11/19/21	4,013	10	$174	$287	$21	$43	$525	$0.115	29	56%	13,692,356
11/20/21	12/21/21	5,876	12	$252	$420	$21	$52	$745	$0.114	32	64%	20,048,912
TOTALS		55,738	12	$2,309	$3,975	$252	$498	$7,033	$0.113	367	51%	190,178,056

Indian Hills High School							ELECTRIC METER #5					
Provider:	Rockland Electric Company			Account #	25796-47002				Meter #	701121590		
Commodity:	Mid American Energy Services			Commodity					Rate Tariff			
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Customer Charge	Electric Demand Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/21/20	1/22/21	4,976	9	$202	$348	$21	$34	$605	$0.110	33	73%	16,978,112
1/23/21	2/22/21	4,690	9	$190	$334	$21	$37	$582	$0.112	31	69%	16,002,280
2/23/21	3/22/21	3,737	8	$148	$267	$21	$30	$467	$0.111	28	71%	12,750,644
3/23/21	4/20/21	1,047	7	$41	$75	$21	$27	$164	$0.111	29	21%	3,572,364
4/21/21	5/20/21	672	3	$26	$48	$21	$11	$106	$0.111	30	28%	2,292,864
5/21/21	6/21/21	674	4	$27	$48	$21	$13	$110	$0.112	32	24%	2,299,688
6/22/21	7/21/21	687	5	$30	$49	$21	$17	$117	$0.115	30	21%	2,344,044
7/22/21	8/20/21	771	4	$34	$55	$21	$16	$126	$0.116	30	26%	2,630,652
8/21/21	9/21/21	842	4	$37	$60	$21	$15	$133	$0.116	32	27%	2,872,904
9/22/21	10/21/21	809	3	$35	$58	$21	$11	$125	$0.115	30	36%	2,760,308
10/22/21	11/19/21	782	4	$34	$56	$21	$13	$124	$0.115	29	26%	2,668,184
11/20/21	12/21/21	2,583	5	$112	$185	$21	$17	$335	$0.115	32	64%	8,813,196
TOTALS		22,270	9	$917	$1,583	$252	$242	$2,994	$0.112	366	28%	75,985,240

Indian Hills High School							ELECTRIC METER #6					
Provider:	Rockland Electric Company			Account #	15710-74006				Meter #	701032438		
Commodity:	Mid American Energy Services			Commodity					Rate Tariff			
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Customer Charge	Electric Demand Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/21/20	1/22/21	19	0	$1	$1	$21	$0	$23	$0.111	33	$0.00	64,828
1/23/21	2/22/21	18	0	$1	$1	$21	$0	$23	$0.113	31	$0.00	61,416
2/23/21	3/22/21	16	0	$1	$1	$21	$0	$23	$0.111	28	$0.00	54,592
3/23/21	4/20/21	16	0	$1	$1	$21	$0	$23	$0.111	29	$0.00	54,592
4/21/21	5/20/21	22	1	$1	$2	$21	$4	$28	$0.110	30	2%	75,064
5/21/21	6/21/21	18	0	$1	$1	$21	$0	$23	$0.112	32	$0.00	61,416
6/22/21	7/21/21	16	0	$1	$1	$21	$0	$23	$0.116	30	$0.00	54,592
7/22/21	8/20/21	17	0	$1	$1	$21	$0	$23	$0.116	30	$0.00	58,004
8/21/21	9/21/21	17	0	$1	$1	$21	$0	$23	$0.116	32	$0.00	58,004
9/22/21	10/21/21	20	0	$1	$1	$21	$0	$23	$0.115	30	$0.00	68,240
10/22/21	11/19/21	20	0	$1	$1	$21	$0	$23	$0.115	29	$0.00	68,240
11/20/21	12/21/21	22	0	$1	$2	$21	$0	$24	$0.114	32	$0.00	75,064
TOTALS		221	1	$9	$16	$252	$4	$282	$0.113	366	2%	754,052

Indian Hills High School								ELECTRIC METER #7				
Provider:	Rockland Electric Company			Account #	25376-47002				Meter #	701121608		
Commodity:	Mid American Energy Services			Commodity	Electric				Rate Tariff			
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Customer Charge	Electric Demand Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/21/20	1/22/21	1,506	4	$61	$105	$21	$13	$200	$0.110	33	49%	5,138,472
1/23/21	2/22/21	1,633	4	$66	$116	$21	$13	$216	$0.112	31	56%	5,571,796
2/23/21	3/22/21	1,152	4	$46	$82	$21	$13	$162	$0.111	28	44%	3,930,624
3/23/21	4/20/21	883	4	$35	$63	$21	$13	$131	$0.111	29	33%	3,012,796
4/21/21	5/20/21	561	4	$22	$40	$21	$13	$96	$0.111	30	20%	1,914,132
5/21/21	6/21/21	693	2	$28	$50	$21	$7	$106	$0.112	32	46%	2,364,516
6/22/21	7/21/21	639	2	$28	$46	$21	$7	$101	$0.115	30	50%	2,180,268
7/22/21	8/20/21	651	2	$29	$47	$21	$6	$103	$0.116	30	57%	2,221,212
8/21/21	9/21/21	742	2	$33	$53	$21	$9	$116	$0.116	32	42%	2,531,704
9/22/21	10/21/21	838	7	$37	$60	$21	$27	$145	$0.115	30	17%	2,859,256
10/22/21	11/19/21	684	7	$30	$49	$21	$28	$127	$0.115	29	13%	2,333,808
11/20/21	12/21/21	869	3	$38	$62	$21	$8	$129	$0.115	32	45%	2,965,028
TOTALS		10,851	7	$451	$773	$252	$154	$1,630	$0.113	366	17%	37,023,612



Indian Hills High School							Natural Gas Meter #1		
Provider	PSEG		Account #	6708520303				Meter #	2415508
Commodity			Commodity					Rate Tariff:	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Customer Charge	Gas Demand Charge	Gas Commodity Charges	Gas Total Charges	$/Therm Marginal Rate	BTU
12/20/20	1/13/21	22,683	$3,251	$153	$2,596	$9,878	$15,877	$0.69	2,268,337,000
1/14/21	2/12/21	26,452	$3,846	$153	$3,750	$11,519	$19,268	$0.72	2,645,165,400
2/13/21	3/16/21	22,675	$3,370	$153	$3,750	$9,874	$17,147	$0.75	2,267,504,000
3/17/21	4/15/21	10,409	$1,548	$153	$0	$4,533	$6,234	$0.58	1,040,917,400
4/16/21	5/13/21	5,887	$877	$153	$0	$2,564	$3,593	$0.58	588,707,100
5/14/21	6/15/21	1,271	$84	$155	$0	$554	$792	$0.50	127,135,200
6/16/21	7/15/21	113	$7	$158	$0	$49	$214	$0.50	11,327,500
7/16/21	8/13/21	4	$1	$158	$0	$2	$160	$0.62	415,700
8/14/21	9/14/21	41	$3	$158	$0	$18	$178	$0.50	4,056,900
9/15/21	10/13/21	1,748	$241	$158	$0	$761	$1,160	$0.57	174,823,900
10/14/21	11/12/21	9,209	$1,429	$158	$3,820	$4,010	$9,416	$1.01	920,856,400
11/13/21	12/14/21	19,078	$3,076	$160	$3,860	$8,308	$15,404	$0.80	1,907,844,100
TOTALS		119,571	$17,732	$1,866	$17,776	$52,068	$89,443	$0.73	11,957,090,600

Indian Hills High School							
Provider	Oakland Borough Water Department			Water & Sewer (Gal)			
Acct #	10209000-1-4						
Billing Period Start Date	**Actual Reading**	**Water & Sewer (Gal)**	**Fixed Charges**	**Usage Charges**	**Total Charges**	**Cost / Unit Checksum**	**BTU**
1/27/21	**4/29/21**	**85,000**	**$0**	**$516**	**$516**	**$0.0061**	**0**
4/30/21	**8/4/21**	**661,100**	**$0**	**$5,049**	**$5,049**	**$0.0076**	**0**
8/5/21	**10/30/21**	**249,200**	**$0**	**$1,652**	**$1,652**	**$0.0066**	**0**
10/31/21	**1/28/22**	**188,700**	**$0**	**$1,338**	**$1,338**	**$0.0071**	**0**
TOTALS		**1,184,000**	**$0**	**$8,556**	**$8,556**	**$0.0072**	**0**

Energy Savings Utility Rates

DCO Energy used the following marginal rates to calculate energy cost savings:

CALCULATED UTILITY RATES - MARGINAL RATES USED FOR SAVINGS					
BUILDING/FACILITY	ELECTRIC			NATURAL GAS	Water & Sewer (Gal)
	$ / kW	$ / kWh Marginal Rate	$ / kWh Blended Rate	$ / Therm Marginal Rate	$ / Gal Marginal Rate
Ramapo High School	$7.44	$0.098	$0.125	$0.78	$0.0102
Indian Hills High School	$7.11	$0.098	$0.124	$0.73	$0.0072

ENERGY SAVINGS PLAN

SECTION 3 – ENERGY CONSERVATION MEASURES

Energy Conservation Measure Breakdown by Building

The matrix below details which ECMs were applied and evaluated by building.

RAMAPO INDIAN HILLS RHSD

✔	ECM evaluated but not included
✔ (green)	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
1	LED Lighting Retrofit	✔ (included)	✔ (included)
2	Lighting Controls	✔ (included)	✔ (included)
3	Energy Management System Integration	✔ (included)	✔ (included)
4	Boiler Replacement	✔ (included)	
5	Premium Efficiency Pump Motors and VFDs	✔ (included)	
6	Rooftop Unit Replacement	✔ (evaluated, not included)	✔ (evaluated, not included)
7	Split System Replacement	✔ (evaluated, not included)	✔ (evaluated, not included)
8	Building Envelope Weatherization	✔ (included)	✔ (included)
9	High Efficiency Transformers	✔ (evaluated, not included)	✔ (evaluated, not included)
10	Freezer Thermostat Control	✔ (included)	✔ (included)
11	Water Conservation	✔ (included)	✔ (included)
12	Plug Load Controls	✔ (included)	✔ (included)
13	Retro-Commissioning	✔ (included)	✔ (included)
14	Solar PPA	✔ (included)	✔ (included)
15	Combined Heat & Power Unit		✔ (evaluated, not included)
16	Roofing Upgrades	✔ (included)	✔ (included)
17	Unit Ventilator Replacement	✔ (evaluated, not included)	✔ (evaluated, not included)
18	Variable Refrigerant Flow Installation	✔ (evaluated, not included)	✔ (evaluated, not included)
19	Rooftop Unit and VRF Installation	✔ (evaluated, not included)	✔ (evaluated, not included)
20	Field Lighting Fixture Replacement	✔ (evaluated, not included)	✔ (evaluated, not included)

ECM Breakdown by Cost & Savings

RAMAPO INDIAN HILLS RHSD		INCLUDED IN PROJECT	INSTALLED COST	ANNUAL ELECTRIC COST SAVINGS	ANNUAL NATURAL GAS COST SAVINGS	ANNUAL Water & Sewer (Gal) COST SAVINGS	ANNUAL ENERGY COST SAVINGS	ANNUAL O&M COST SAVINGS	TOTAL ANNUAL COST SAVINGS	SIMPLE PAYBACK WITHOUT INCENTIVES
ECM #	ENERGY CONSERVATION MEASURE	"Y" OR "N"	$	$	$	$	$	$	$	YEARS
1	LED Lighting Retrofit	Y	$1,246,175	$126,311	($1,581)	$0	$124,730	$18,285	$143,015	8.7
2	Lighting Controls	Y	$118,648	$8,380	($106)	$0	$8,274	$0	$8,274	14.3
3	Energy Management System Integration	Y	$391,748	$8,018	$26,976	$0	$34,994	$10,754	$45,748	8.6
4	Boiler Replacement	Y	$0	$0	$5,959	$0	$5,959	$4,169	$10,128	0.0
5	Premium Efficiency Pump Motors and VFDs	Y	$0	$3,148	$0	$0	$3,148	$0	$3,148	0.0
8	Building Envelope Weatherization	Y	$138,273	$2,790	$8,278	$0	$11,068	$0	$11,068	12.5
10	Freezer Thermostat Control	Y	$19,154	$3,099	$0	$0	$3,099	$0	$3,099	6.2
11	Water Conservation	Y	$31,234	$0	$1,104	$1,904	$3,007	$0	$3,007	10.4
12	Plug Load Controls	Y	$30,940	$2,174	$0	$0	$2,174	$0	$2,174	14.2
13	Retro-Commissioning	Y	$218,000	$11,502	$7,110	$0	$18,612	$0	$18,612	11.7
14	Solar PPA	Y	$0	$150,710	$0	$0	$150,710	$0	$150,710	0.0
16	Roofing Upgrades	Y	$2,290,000	$261	$980	$0	$1,240	$0	$1,240	1,846.5
TOTALS			$4,484,172	$316,394	$48,720	$1,904	$367,017	$33,208	$400,225	11.2

RAMAPO INDIAN HILLS RHSD		INCLUDED IN PROJECT	ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	NATURAL GAS SAVINGS	Water & Sewer (Gal) SAVINGS	TOTAL SITE ENERGY SAVINGS	TOTAL SOURCE ENERGY SAVINGS
ECM #	ENERGY CONSERVATION MEASURE	"Y" OR "N"	kWh	kW	THERMS	Water & Sewer (Gal)	MMBTU	MMBTU
1	LED Lighting Retrofit	Y	1,002,596	355	(2,090)	0	3,212	9,359
2	Lighting Controls	Y	66,436	23	(139)	0	213	620
3	Energy Management System Integration	Y	62,595	22	35,562	0	3,770	4,332
4	Boiler Replacement	Y	0	0	7,620	0	762	800
5	Premium Efficiency Pump Motors and VFDs	Y	29,670	3	0	0	101	283
8	Building Envelope Weatherization	Y	12,165	18	10,947	0	1,136	1,266
10	Freezer Thermostat Control	Y	31,623	0	0	0	108	302
11	Water Conservation	Y	0	0	1,450	212355	145	152
12	Plug Load Controls	Y	22,188	0	0	0	76	212
13	Retro-Commissioning	Y	117,369	0	9,407	0	1,341	2,109
14	Solar PPA	Y	0	0	0	0	0	27,115
16	Roofing Upgrades	Y	2,660	0	1,288	0	138	161
TOTALS			1,347,301	421	64,045	212355	11,001	46,712

ECM Breakdown by Greenhouse Gas Reduction

RAMAPO INDIAN HILLS RHSD		INCLUDED IN PROJECT	Reduction of CO_2	Reduction of No_x	Reduction of SO_2	Reduction of Hg
ECM #	ENERGY CONSERVATION MEASURE	"Y" OR "N"	LBS	LBS	LBS	LBS
1	LED Lighting Retrofit	Y	1,078,407	933	2,216	4,662
2	Lighting Controls	Y	71,454	62	147	309
3	Energy Management System Integration	Y	484,925	387	138	291.1
4	Boiler Replacement	Y	89,157	70	0	0
5	Premium Efficiency Pump Motors and VFDs	Y	32,637	28	66	138
8	Building Envelope Weatherization	Y	141,465	112	27	57
10	Freezer Thermostat Control	Y	34,785	30	70	147.0
11	Water Conservation	Y	16,959	13	0	0.0
12	Plug Load Controls	Y	24,407	21	49	103
13	Retro-Commissioning	Y	239,164	198	259	546
14	Solar PPA	Y	3,122,060	2,696	6,273	13,198
16	Roofing Upgrades	Y	17,993	14	6	12
TOTALS			5,353,412	4,565	9,250	19,463

Note: Factors used to calculate Greenhouse Gas Reductions are as follows.

	UTILITIES			
	ELECTRIC	NATURAL GAS	OTHER ENERGY #2	OTHER ENERGY #3
UNITS	kW & kWh	Therms	Solar PPA (kWh)	Water & Sewer (Gal)
BTU MULTIPLIER	3,412	100,000	3,412	0
CO2 EMISSION FACTOR (LB CO2/UNIT FUEL)	1.10	11.70	0.00	0.00
SITE-SOURCE MULTIPLIER	2.80	1.05	1.00	0.00

- ***NOx = (0.00095*kWh Savings) + (0.0092*Therm Savings)***
- ***SO2 = (0.00221*kWh Savings)***
- ***Hg = (0.00465*kWh Savings)***

See Combined Heat and Power ECM for emission calculation per NJ BPU Protocols.

ECM Breakdown by Building

Please see Appendix F for ECM Breakdown by Building.

ECM Budgeting Narrative

Detailed plans, schematics and specifications for Ramapo Indian Hills Regional High School District were not available to deliver a cost estimate for each ECM. The budgetary costs carried in the project are based on good faith estimates, contractor supplied budgets for similar ECMs on other recent projects and a database of actual installed costs for various ECMs.

RAMAPO INDIAN HILLS RHSD		INSTALLED COST
ECM #	ENERGY CONSERVATION MEASURE	$
1	LED Lighting Retrofit	$1,246,175
2	Lighting Controls	$118,648
3	Energy Management System Integration	$391,748
4	Boiler Replacement	$0
5	Premium Efficiency Pump Motors and VFDs	$0
8	Building Envelope Weatherization	$138,273
10	Freezer Thermostat Control	$19,154
11	Water Conservation	$31,234
12	Plug Load Controls	$30,940
13	Retro-Commissioning	$218,000
14	Solar PPA	$0
16	Roofing Upgrades	$2,290,000
	TOTALS	$4,484,172

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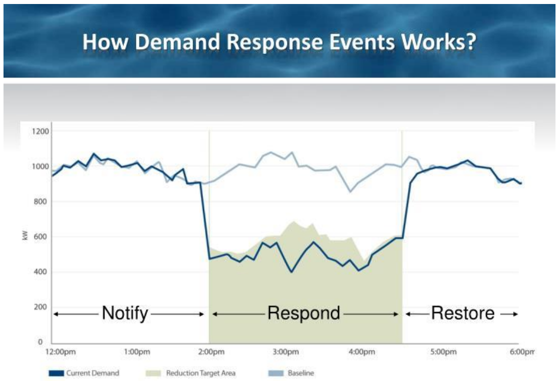
Demand Response & Project Incentives Analysis

Demand Response

Demand Response (DR) is a voluntary Pennsylvania-Jersey-Maryland (PJM) Interconnection program that allows end use customers to reduce their electricity usage during periods of higher power prices. In exchange, end-use customers are compensated through PJM members known as Curtailment Service Providers (CSPs) for decreasing their electricity use when requested by PJM.

Common reduction strategies used in Demand Response include:

- Manual or automatic load drop
- Energy management systems
- Load shedding strategies
- Lighting control strategies
- Backup generation
- Ice storage systems



Benefits of the program include:

- Significant source of new revenue
- Helps to ensure local grid reliability
- Reduces the need for new environmentally taxing energy generation

In the base product, customers commit to reducing their load at the direction of PJM during emergency conditions during the summer months. In the Capacity Performance product, the customer will need to be able to reduce load when directed during the entire year.

Engineered Solutions

Engineered Solutions is a PSE&G rebate program that provides bid savings and bid-ready designs on whole-building energy efficiency upgrades for large facilities. Eligible customers include municipalities, colleges, schools, hospitals, non-profits, and multi-family housing. The program makes it easy and affordable to upgrade to high efficiency HVAC equipment. The program targets comprehensive upgrades of electric and gas measures for multiple building systems, including lighting, HVAC, motors and drives, refrigeration, appliances, boilers, and furnaces. The process of the Engineered Solutions program requires an investment grade audit. This audit was conducted by DCO Energy with PSEG oversight and approval of all energy savings and rebates.

Direct Install

Created specifically for existing small to mid-sized facilities, Direct Install is a turnkey project solution that makes it easy and affordable to upgrade to high-efficiency equipment. The program provides a free energy assessment, and a participating contractor will work with you to cut your facility's energy costs by replacing lighting, HVAC and other outdated operational equipment with energy efficient alternatives.

The DI Program is open to all eligible commercial and industrial customers whose *average* demand did not exceed 200 kW in any of the preceding twelve months, have their gas or electricity provided by one of New Jersey's Investor-Owned Utilities (IOUs), and pay into the Societal Benefits Charge (SBC).

To dramatically improve your payback on the project, the program pays up to 80% of retrofit costs to facilities within an Urban Enterprise Zone, Opportunity Zone, owned or operated by a local government, K-12 public school, or designated as affordable housing. Other types of facilities receive an incentive up to 70% of retrofit costs.

In 2019 the Direct Install program surpassed $200 million in incentives provided since its inception.

Systems and Equipment Addressed by the Program:

- Lighting & Lighting Controls
- Heating, Cooling & Ventilation (HVAC) and HVAC Controls
- Refrigeration
- Motors
- Variable Frequency Drives
- Hot Water Conservation Measures

* As of July 1, 2021, all of former NJ Clean Energy Program incentive programs transitioned over to the investor-owned gas and electric utility companies. Subsequently, the BPU is requiring that all ESIP projects consult with the DCA and follow all DCA guidance regarding the procurement of all subcontractors.

Combined Heat & Power

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

Eligible CHP or Waste Heat to Power (WHP) projects must achieve an annual system efficiency of at least 60% (Higher Heating Value - HHV), based on total energy input and total utilized energy output. Mechanical energy may be included in the efficiency evaluation.

In order to qualify for incentives, systems must operate a minimum of 5,000 full-load equivalent hours per year (i.e. run at least 5,000 hours per year at full rated kW output). The Office of Clean Energy (OCE) may grant exceptions to this minimum operating hours requirement for Critical Facilities, provided the proposed system operates a minimum of 3,500 full-load equivalent hours per year and is equipped with blackstart and islanding capability. For this program, a Critical Facility is defined as any:

(a) public facility, including any federal, state, county, or municipal facility,

(b) non-profit and/or private facility, including any hospital, police station, fire station, water/wastewater treatment facility, school, multifamily building, or similar facility that:

  (A) is determined to be either Tier 1 or critical infrastructure by the New Jersey Office of Emergency Management or the State Office of Homeland Security and Preparedness or

  (B) could serve as a Shelter during a power outage. A Shelter is a facility able to provide food, sleeping arrangements, and other amenities to its residents and the community.

The CHP, FC, or WHP system must have a ten (10) year all-inclusive warranty. The warranty must cover the major components of the system eligible for the incentive, to protect against breakdown or degradation in electrical output of more than ten percent from the originally rated electrical output. The warranty shall cover the full cost of repair or replacement of defective components or systems, including coverage for labor costs to remove and reinstall defective components or systems. In the event the system warranty does not meet program requirements, customer must purchase an extended warranty or a ten (10) year maintenance/service contract. The cost of the ten (10) year warranty or service contract may be considered as part of the cost of the project. Notwithstanding the foregoing, public entities that are prohibited from entering into agreements for the full ten (10) years may comply with the 10-year requirement by:

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(a) providing an agreement for the longest lawful term,
(b) committing the entity to purchase an agreement for the remaining years, and
(c) either:
(i) providing the vendor's commitment for specific pricing for those remaining years, or
(ii) assuming the pricing for the remaining years will increase by 2.5% each year

Incentive Structure:

Eligible Technologies	Size (Installed Rated Capacity)	Incentive ($/kW)	% of Total Cost Cap per project[3]	$ Cap per project[3]
Powered by non-renewable or renewable fuel source, or combination[4]: Gas Internal Combustion Engine; Gas Combustion Turbine; Microturbine; Fuel Cells with Heat Recovery (FCHR)	≤500 kW	$2,000	30-40%[2]	$2 million
	>500 kW - 1 MW	$1,000		
	> 1 MW - 3 MW	$550	30%	$3 million
	>3 MW	$350		
Fuel Cell without Heat Recover (FCwoHR)	Same as above(1)	Applicable amount above	30%	$1 million
Waste Heat to Power	≤ 1MW	$1,000	30%	$2 million
	> 1MW	$500		$3 million

Footnotes:

(1) Incentives are tiered, which means the incentive levels vary based upon the installed rated capacity, as listed in the chart above. For example, a 4 MW CHP system would receive $2.00/watt for the first 500 kW, $1.00/watt for the second 500 kW, $0.55/watt for the next 2 MW and $0.35/watt for the last 1 MW (up to the caps listed).

(2) The maximum incentive will be limited to 30% of total project. For CHP-FC projects up to 1 MW, this cap will be increased to 40% where a cooling application is used or included with the CHP system (e.g. absorption chiller).

(3) Projects will be eligible for incentives shown above, not to exceed the lesser of % of total project cost per project cap or maximum $ per project cap. Projects installing CHP or FC with WHP will be eligible for incentive shown above, not to exceed the lesser caps of the CHP or FC incentive. Minimum efficiency will be calculated based on annual total electricity generated, utilized waste heat at the host site (i.e. not lost/rejected), and energy input.

(4) Systems fueled by a Class 1 Renewable Fuel Source, as defined by N.J.A.C. 14:8-2.5, are eligible for a 30% incentive bonus. If the fuel is mixed, the bonus will be prorated accordingly. For example, if the mix is 60/40 (60% being a Class 1 renewable), the bonus will be 18%. This bonus will be included in the final performance incentive payment, based on system performance and fuel mix consumption data. Total incentive, inclusive of bonus, shall not exceed above stipulated caps.

(5) CHP or FC systems located at Critical Facility and incorporating blackstart and islanding technology are eligible for a 25% incentive bonus. This bonus incentive will be paid with the second/Installation incentive payment. Total incentive, inclusive of bonus, shall not exceed above stipulated caps.

Incentive Payment Schedule

The total incentive is divided into three partial payments. Each stage of payment requires additional documentation and/or has conditions that must be met. At approval, the maximum incentive partial payment amounts are calculated by multiplying the total incentive by the ratios listed in the following table.

Purchase	Installation	Acceptance of 12 months post-installation performance data
30%	50%	20%

(e.g., for the purpose of calculating a payback period)

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Incentive Calculations

All estimated incentive values for RIHRHSD ESIP project were provided by PSE&G through the Engineered Solutions Program. The total incentive amount was calculated to be $931,358.52. The Engineered Solutions program is estimated to cover 57% of the installed cost of the improvements with the remainder financed within the ESIP.

*On-Bill Financing will not be pursued; the customer share of $702,119.24 will be paid upon completion of the project using ESIP funds.

PSEG

Engineered Solutions Energy Efficiency Program

Date: 11/1/2022

Ramapo Indian Hills BOE ESIP

Item	Measure Description	Measure Cost ($)	1st Year Measure Savings ($)
1	Interior & Exterior Lighting	$1,217,443.66	$128,003
2	Lighting Controls	$118,648.13	$8,533
3			
4			
5	Building Envelope Weatherization	$138,273.00	$10,539
6			
7	Freezer Thermostat Control	$19,154.22	$4,094.06
8	Low Flow Fixtures	$31,234.11	$1,183.47
9	Plug Load Controls	$30,939.98	$2,872.61
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
	Total ECM Cost	$1,555,693.10	
	Construction Management		
	Total Advanced Project Cost	$1,555,693.10	
	Engineering Costs	$77,784.66	
	Total Project Cost	$1,633,477.76	$155,226

Summary Table	
Customer Payback from Savings (Yrs.)	4.5
Customer Share of the Project Cost	$ 702,119.24
PSE&G Share of the Project Cost	$ 931,358.52
Customer % Share of the Project Cost	43%
PSE&G % Share of the Project Cost	57%
Stage 1 - Initial Payment	$ 466,707.93
1st Year Measure Savings	$ 155,226.42
Annual Loan Repayment	$ (140,423.85)
1st Year Net Cash Flow	$ 14,802.57
Monthly Payment	$ 11,701.99

No implied and/or written guarantee is made with respect to the receipt of incentives. All incentives estimates carry inherent risks that may jeopardize the receipt of them. Therefore, Ramapo Indian Hills Regional High School District acknowledges and accepts that any project proposed should not rely on the receipt of incentives as a reason to implement it.

ECM 1 & 2 – LED Lighting Retrofit & Lighting Controls

RAMAPO INDIAN HILLS RHSD

✓	ECM evaluated but not included
✓ (green)	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
1	LED Lighting Retrofit	✓	✓
2	Lighting Controls	✓	✓

Lighting retrofits can greatly reduce energy consumption and lower energy bills, while maintaining lighting levels and quality by upgrading lighting components to more efficient and advanced technologies. Upgrading technologies can also offer employees greater control over lighting, allowing for additional energy savings

Improvements in lighting technologies have led to increased lifetimes for components that will result in fewer failures and lengthen the time between maintenance activities.

The implementation of a routine maintenance program in addition to the lighting retrofit will greatly simplify the maintenance practices and reduce the operational costs.

Lighting controls can save energy and reduce peak demand in offices and other facilities. Controls save money while providing the user convenience and an improved lighting environment. There are several different kinds of controls. The choice of control type should be based on lighting usage patterns and the type of space served.

Areas with intermittent occupancy are well-suited to occupancy sensors. In large, open office areas with many occupants, scheduled switching ("time scheduling") is often an effective energy-saving strategy. In daylight offices, properly adjusted daylight sensors with dimming ballasts make sense. Because some workers prefer lower lighting levels, bi-level manual switching is another option. Advanced lighting controls can be used for demand limiting to allow building managers to reduce lighting loads when electricity demand costs are high.

Existing Conditions

Existing interior lighting at Ramapo High School and Indian Hills High School

Scope of Work – LED Lighting Retrofit

Retrofit or replace existing interior and exterior fixtures with LED bulbs/fixtures as proposed in the line-by-lines in Appendix G. The new LED tubes do not require the existing fluorescent ballasts to operate (Type B retrofit). The existing ballasts across the district will be removed during this implementation.

Scope of Work – Lighting Controls

Add occupancy sensors to existing spaces to control LED tubes. Refer to appendix G for additional details.

ECM Calculations

LED lighting and control savings were calculated based on PSEG Engineered solutions protocol. A coincidence factor is applied to estimate peak demand savings. The impact on the HVAC systems is captured as well. See Appendix G for Lighting Line-by-Lines, LED Lighting Replacement savings calculation and Lighting Controls savings calculation.

CALCULATED SAVINGS

LED Lighting Replacement Savings

BUILDING	SQFT	Peak Demand Savings (kW)	Annual Demand Savings (kW)	Total Energy Savings (kWh)	Total Fuel Savings (therms)
Ramapo High School	241,600	124.9	173.5	490,522.6	-1,022.2
Ramapo High School					
Ramapo High School					
Indian Hills High School	240,320	130.4	181.1	512,073.3	-1,067.5
Indian Hills High School					
Indian Hills High School					

CALCULATED SAVINGS

Lighting Control Savings

BUILDING	SQFT	Lighting Control Peak Demand Savings (kW)	Lighting Control Annual Demand Savings (kW)	Lighting Control Energy Savings (kWh)	Lighting Control Fuel Savings (therms)
Ramapo High School	241,600	11.02	15.30	43,339	-91
Ramapo High School					
Ramapo High School					
Indian Hills High School	240,320	5.87	8.15	23,096	-48
Indian Hills High School					
Indian Hills High School					

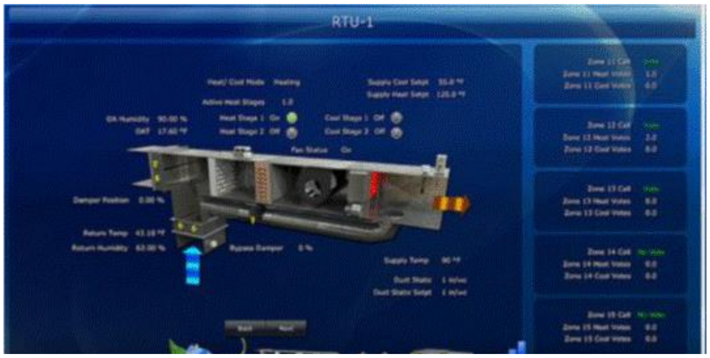
ECM 3 – Energy Management System Integration

RAMAPO INDIAN HILLS RHSD

✓	ECM evaluated but not included
✓ (green)	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
3	Energy Management System Integration	✓	✓

Energy Management Systems (EMS) are systems comprised of sensors, operators, processors, and a front-end user interface that controls and monitors electrical and mechanical building systems. Such systems provide automated control and monitoring of the heating, cooling, ventilation, lighting and performance of a building or group of buildings. The energy management system will provide Ramapo Indian Hills Regional High School District with continuous monitoring & reporting.

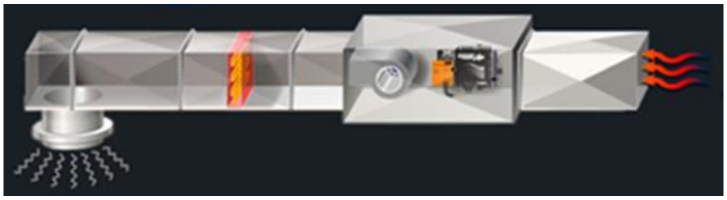


Web Based Building Automation Interface

Having building systems monitored from a central location enables the operator to receive alerts and predict future problems or troublesome conditions. The data obtained from these can be used to produce a trend analysis and annual consumption forecasts. Advanced control strategies implemented using these systems such as time scheduling, optimum start and stop, night set-back, demand-controlled ventilation, and peak demand limiting. The auditor will be able to use the EMS to diagnose current building system problems as well as tailor specific energy savings strategies that utilize the full capability of the given EMS.

The upgraded District Wide EMS will integrate existing proprietary systems with new Open Protocol DDC Controls. Control strategies will be designed and programmed into the system to maintain building comfort while operating the building mechanical system in the most efficient manner possible. Strategies include:

1. Occupancy Scheduling
2. Building Wide Night Set Back
3. Morning Warm Up
4. Individual Room Temperature Set Point Control
5. Supply Air Temperature Reset
6. Chilled & Heating Supply Water Temperature Resets
7. Economizer Control
8. CO2 Ventilation Control

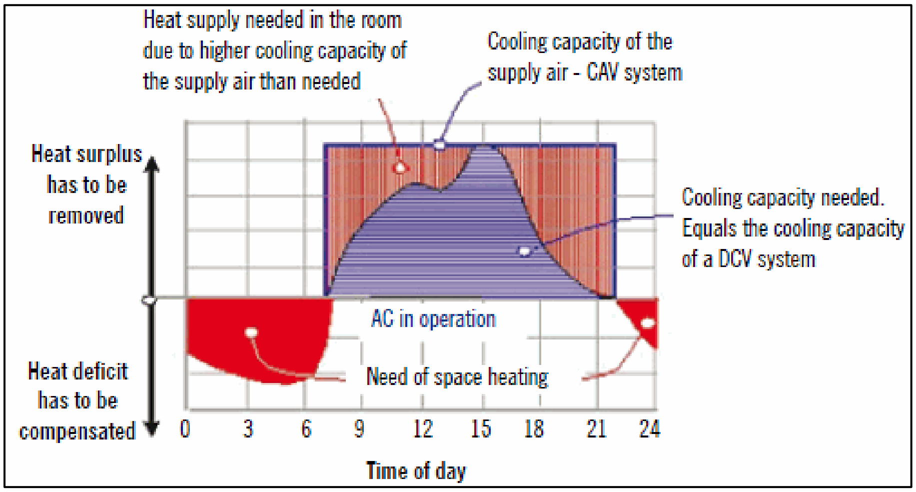


Demand Control Ventilation

In most commercial occupancies, ventilation is provided to deal with two types of indoor pollution: (1) odors from people, and (2) off-gassing from building components and furniture. When a space is vacant, it has no people pollution, so the people-related ventilation rate is not needed. Many types of high-occupancy spaces, such as classrooms, multipurpose rooms, theaters, conference rooms, or lobbies have ventilation designed for a high peak occupancy that rarely occurs. Ventilation can be reduced during the many hours of operation when spaces are vacant or at lower than peak occupancy. When ventilation is reduced, building owners or operators save energy because it is not necessary to heat or cool as much outside air. In colder climates, heating for ventilation air is greater and DCV saves the most energy.

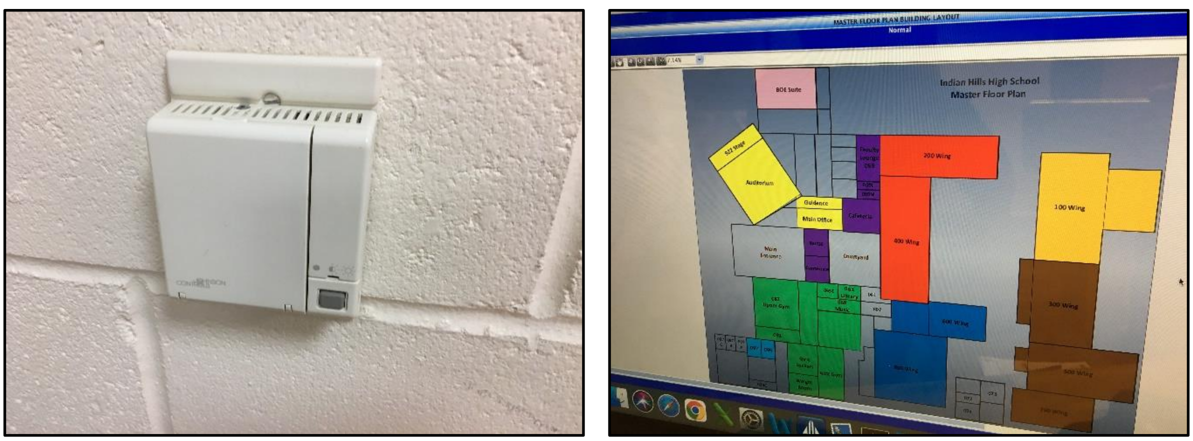
Demand Control Ventilation Operation

The objective of a CO2 control strategy is to modulate ventilation to maintain target cfm/person ventilation rates based on actual occupancy. The strategy should allow for reduced overall ventilation during periods of less than full occupancy which will save energy. Typical control approaches have used a proportional or proportional-integral control algorithm to modulate ventilation between a base ventilation rate established for non-occupant-related sources and the design ventilation rate for the space. Typically, modulation of outside air above base ventilation begins when indoor CO2 is 100 ppm above outside levels and continues until the target CO2 levels are reached and the design ventilation rate is provided.



Duct sensors are best used where a single space or multiple spaces with common occupancy patterns are being ventilated. An example of this approach would be to place a sensor in the return duct of an air handler that serves multiple classrooms, using an upper limit set point of 500 or 600 ppm CO2 above ambient (instead of 700 ppm). This approach works best when the AHU system is serving spaces that are occupied with very similar schedules and rates.

Existing Conditions



Existing controls at Ramapo High School and Indian Hills High School

Ramapo Indian Hills Regional High School District's existing energy management system is direct digital Johnson Controls Metasys system. The district can view both high schools on a central front end and does have the capability to develop unoccupied/occupied schedules, set space temperature set points, and view any alarms or specific unit issues. Both buildings have NAE/NCE Supervisory Network Controllers and outdated graphics on the system front end.

These network controllers are legacy DDC and are no longer in production. Humidity monitoring is currently available in only specific locations on the district front end.

Scope of Work

This measure involves upgrading the existing control system with an open-protocol, web-based Energy Management system. A Direct Digital Controller, which leverages current technology and advance capabilities for the control of the new HVAC equipment, will tie into the existing EMS's architecture. Additionally, where the existing HVAC equipment is to remain, integration to the existing legacy Direct Digital Controllers onto the new EMS Open platform will occur. The Open platform proposed is based on the Johnson Niagara 4 frameworks. The allows the owner the advantage of having the availability of obtaining replacement and services of the proposed EMS through multiple commercial channels and provides an additional benefit of an Open-Source Building Management System. This distinctive feature unleashes the owner from obtaining support from only a single source provider, allowing them instead to obtain support from readily available multiple sources.

The proposed energy management system will be able to vary the operation of the unit, outdoor air damper, space temperature set points, and air conditioning systems (if applicable). This will include zone scheduling, temperature setback and unoccupied outdoor air shut off. Each building will be provided with electric and natural gas submetering for continuous monitoring and reporting of building energy consumption via Energy Dashboards.

A more specific scope of work includes:

- Building Automation Systems shall be accessible via the Internet.
- User shall have the ability to view the system graphics, change set points, perform overrides, view schedules, change schedules, view alarms, acknowledge alarms, view trend information as well as print, save & e-mail trend information.
- A Secure Internet Connection to the District Network shall be provided and managed by the District IT Department.
- 3-D Graphics Package will be provided for navigating the Building Automation System as well as viewing floor plans, system graphics and equipment graphics.
- The District Facilities and IT Staff will receive full training on the operation of the system.
- Humidity monitoring in all occupied spaces
- Demand Control Ventilation (DCV) will be utilized in the following spaces:

Demand Control Ventilation Scope of Work			
BUILDING	Componet	HVAC Unit #	Quantity
Ramapo High School	Auditorium	RTU-1A	1
	Cafeteria	RTU-2N	1
	Main Gym	HV-3D / HV-4D	2
	Lower Gym	AHU-1 / AHU-2	2
Indian Hills High School	Auditorium	AHU-1 / CU-1	1
	Cafeteria	AHU-1	1
	Gym	HV-1	1
	Lower Gym	RTU-3	1

District Management Detailed Controls Upgrade

District Building Management System Infrastructure

- The new Building Management System is based on a Web Johnson Niagara 4 (FX) Platform, Open Source/Open System Building Network Communication bus (BACnet) to each new DDC controller
- The existing BMS's legacy Supervisory Network Controller (SNC) TCP/IP network connection shall be re-utilized for the new Johnson FX Supervisory Network Controller(s) and shall be utilized for connection to the BMS. If remote connection to the Building Management System is desired, the owner shall provide a TCP/IP drop at the new Supervisory Network Controller to their WAN.
- Controls group shall verify and warranty for the period of contract specifications the existing communications and/or device wiring which is to remain and be reutilized. If found to be defective, Controls group shall replace this wiring within this scope.
- Where existing is to be reutilized, Controls group shall verify and reuse existing communications network wiring, device wiring, and power sources.
- Furnish and install a Johnson BMS Archival Data Server and Niagara Supervisor with UPS power backup.
- Furnish and install new Johnson FX Niagara 4 Open-Source Web-Based interface for use by the owner's authorized thin-client web-browsers.
- Provide centralized scheduling, alarming, trending, and archival data storage of the Building Management System's controlled HVAC equipment.

Ramapo High School

<u>A. Overview:</u>

- The Ramapo High School building's existing Building Management System is comprised of Four (4) Supervisory Network Controller(s) (NAE/NCE), Twenty (20) Legacy Extended Digital (DX) Controller(s), Seventy-Seven (77) Legacy Unitary (UNT) controller(s), Ten (10) Legacy VAV controller(s) (VMA), Five (5) Vender (VND) controller(s). The replacement/addition of new equipment shall replace the associated controller(s) with a new appropriately sized Open-Source Open System Niagara 4 DDC controller.

- These legacy DDC controller(s) currently incorporate and utilize approximately (435) Analog Input(s)(AI), (250) Analog Output(s)(AO), (937) Analog Value(s)(AV), (252) Binary Input(s)(BI), (342) Binary Output(s)(BO), and (248) Binary Value(s)(BV). There is additional control parameter(s) and setpoint(s) which the BMS requires to function and are also utilized in the control of the BMS which are not depicted but will also be added to the new Building Management System.

- During the project, the new HVAC unit(s) and any of the remaining legacy Building Management System device(s) will be integrated into the Johnson Niagara 4 Platform. The existing HVAC equipment controls which are not replaced (i.e., VAV, HWS, AC, etc..), and their devices shall remain (as-is) and replacement of such is not included within this Scope of Work.

B. RHS Building Management System Upgrade – Base

- Web-Based Customized Color 3-D Graphical User Interface:
  - Furnish and install new Niagara 4 Open-Source Web-Based interface for use by the owner's authorized thin-client web-browsers. The new Graphical User Interface (GUI) shall provide color 3-D graphic of the building layout, with equipment locations depicted, with color 3-D animated graphics for each piece of controlled equipment.

- Building Management System Network Controllers
  - Furnish and install (4) new Niagara 4 Open-Source Supervisory Network Controller(s)(SNC) on each of the campuses, in a new NEMA1 control panel, new Control Power transformer (XT) and Uninterruptible Power Supply (UPS) to communicate with the new Johnson Niagara 4 and existing Legacy DDC devices.

- Existing communication wiring shall be reused all to connect each new Niagara 4 Open Source DDC controllers. The Building Management System legacy communications network shall remain in a daisy chain style.
- Furnish integration of the existing DDC controllers to the Niagara 4 Platform

C. Alternates Included:

- RHS Alternate 1 – Add Relative Humidity Monitoring
    - Budget allocated to furnish and install sensor(s) and devices for the monitoring of Unitary Device Spaces Space Relative Humidity condition.

- RHS Alternate 2 – Add Co2 Sensors / DCV to existing Units
    - Cafeteria (1-RTUs)
    - Main Gym (2-H&V)
    - Lower Gym (2-AHU)
    - Auditorium (1-RTUs)

D. Alternates Excluded: (RTU Replacement and Split System Replacement)

If Ramapo Indian Hills Regional High School District adds ECM 6 & ECM 7 the following will also be included:

RHS Rooftop Unit Replacement – Rooftop Unit Controls

- (14) Roof Top and Air Handling Units
    - (2) New Roof Top Unit(s) RTU-1-2A,2B
    - (8) New Roof Top Unit(s) RTU-1, 1C, 2C, 3C, 4C, 1D, 2D, 1H
    - (1) New Roof Top Unit(s) RTU-209-211
    - (3) New Roof Top Unit(s) RTU-1A, 2A, 3A

- Furnish and install controls and devices for (14) Roof Top Unit(s) Natural Gas or Hot Water Heating / Direct Expansion Cooling (as scheduled).

- The Roof Top Unit(s) shall be furnished by other(s), DDC Ready, (i.e., damper actuator, relays, transformer etc.).

- Furnish and install New Niagara 4 DDC Controller, wall sensor(s) (Reuse the existing wall sensor wiring) and heating valve control wiring. Connection of communication(s) network connection to the Roof Top Unit. The existing interlock wiring and any existing Duct Heater Coil or Fintube Radiation control valve shall be reconnected to the RTU's new Niagara 4 DDC controller.

- Control Points: The control points which are typical of a new Roof Top Unit are:
  - Occupancy Schedule (BV)
  - Min. Outside Air Damper Setpoint (AV)
  - Min. Discharge Air Temp. Setpoint (AV)
  - Global Outside Air Temperature (AV)
  - Supply Fan Low / Med / High (BO x 3) or
  - Speed signal (AO)
  - Unit Fan Status (BI)
  - Space Temperature (AI) w/ local setpoint
  - Occupied Space Heating Setpoint (AV)
  - Occupied Space Cooling Setpoint (AV)
  - Un-Occupied Space Heating Setpoint (AV)
  - Un-Occupied Space Cooling Setpoint (AV)
  - Space Relative Humidity (AI)
  - Discharge Air Temperature (AI)
  - Return Air Temperature (AI)
  - Mixed Air Temperature (AI)
  - Low-Limit Temperature Switch (BI)
  - Filter Status (BV)
  - Heating Control Valve or Stage (AO)/(BO)
  - Fintube Radiation Valve (BO)(where existing)
  - Cooling Stage signal (BOx2)
  - Exh. Fan Start/Stop (BO)(where existing)
  - Economizer Damper signal (AO)
  - Cooling Lockout
  - Heating Lockout
  - CO2 Sensor

- Existing Duct Heating Controls (associated with Roof Top Unit(s))

- The new Johnson Niagara 4 Roof Top Unit DDC controller shall be designed to incorporate the existing control of their associated Duct Heating Coil(s) (~45), (i.e., Analog or Binary, Inputs and Outputs)
- Furnish and install new space temperature sensor(s) with local setpoint control and connect the existing hot water control valve wiring to the New Roof Top Unit DDC controller
- Typical Duct Heater Coil control points: Heating Coil Control valve signal - AO Space temperature w/ local setpoint - AI

- RHS Add Alternate 1-1: CO_2 sensors with demand control ventilation in large spaces
  - Add (6) CO_2 sensor(s) to RTU-1H, RTU-1A, 2A, 3A, RTU-1-2A and 2B

RHS Split System Replacement – Split System Controls

- SPLIT SYSTEM AIR CONDITIONING UNIT(S)
  - SSAC-2 – Gym Office
  - SSAC-5 – 205
  - SSAC-6 – 217A
  - SSAC-15 – 409

- Provide Controls and devices for (8) Split System Air Conditioning Unit(s)(SSAC)

- The SSAC Unit(s) shall be furnished by other(s) and shall incorporate any internal safety device(s) (i.e., high low-pressure cutouts, oat lockouts etc.)

- Furnish and install New Niagara 4 DDC Controller, wall sensor(s) (Reuse the existing wall sensor wiring). Connection of communication(s) network connection to the SSAC Unit.

- Control Points: The control points which are typical of a new Split System Air Conditioning Unit(s) are:
  - Occupancy Schedule (BV)
  - Global Outside Air Temperature (AV)
  - Supply Fan Start/Stop
  - Unit Fan Status (BI)
  - Space Temperature (AI) w/ local setpoint

- Occupied Space Cooling Setpoint (AV)
- Un-Occupied Space Cooling Setpoint (AV)
- Discharge Air Temperature (AI)
- Filter Status (BV)
- Cooling Stage signal (BOx2)

Indian Hills High School

A. Overview:

- The Indian Hills High School building's existing Building Management System is comprised of Four (4) Supervisory Network Controller(s) (NAE/NCE), Nineteen (19) Legacy Extended Digital (DX) Controller(s), Seventy-One (71) Legacy Unitary (UNT) controller(s), Thirty-Two (32) Legacy VAV controller(s) (VMA), Four (4) Vender (VND) controller(s). The replacement/addition of new equipment shall replace the associated controller(s) with a new appropriately sized Open-Source Open System Niagara 4 DDC controller.

- These legacy DDC controller(s) currently incorporate and utilize approximately (535) Analog Input(s)(AI), (263) Analog Output(s)(AO), (979) Analog Value(s)(AV), (384) Binary Input(s)(BI), (328) Binary Output(s)(BO), and (282) Binary Value(s)(BV). There are additional control parameter(s) and setpoint(s) which the BMS requires to function and are also utilized in the control of the BMS which are not depicted but will also be added to the new Building Management System.

- During the project, the new HVAC unit(s) and any of the remaining legacy Building Management System device(s) will be integrated into the Johnson Niagara 4 Platform. The existing HVAC equipment controls which are not replaced (i.e., VAV, HWS, AC, etc..), and their devices shall remain (as-is) and replacement of such is not included within this Scope of Work.

B. IHHS Building Management System Upgrade - Base

- Web-Based Customized Color 3-D Graphical User Interface:
  - Furnish and install new Johnson FX Niagara 4 Open-Source Web-Based interface for use by the owner's authorized thin-client web-browsers. The new Graphical User Interface (GUI) shall provide color 3-D graphic of the building layout, with equipment

locations depicted, with color 3-D animated graphics for each piece of controlled equipment.

- Building Management System Network Controllers:
  - Provide and install (4) new Johnson FX Niagara 4 Open-Source Supervisory Network Controller(s)(SNC) on each of the campuses, in a new NEMA1 control panel, new Control Power transformer (XT) and Uninterruptible Power Supply (UPS) to communicate with the new Johnson Niagara 4 and existing Legacy DDC devices.
  - Existing communication wiring shall be reused all to connect each new Johnson FX Niagara 4 Open Source DDC controllers. The Building Management System legacy communications network shall remain in a daisy chain style.
  - Integration of the existing DDC controllers to the Johnson FX Niagara 4 Platform

- IHHS Combined Heat and Power Monitoring
  - Provide monitoring of the Combined Heating and Power System through a communications integration (BACnet or Modbus). The CHP contractor shall provide technical support including a points list, alarms, and control settings. The CHP contractor shall provide all materials. Installation of such, Sequence of Operations for the CHP system, including the communication interface(s) on the CHP equipment. Provide the communication network for the CHP – BMS interface with Graphics on the BMS.

C. Alternates Included

- IHHS Alternate 1: Add Relative Humidity Monitoring
  - Budget allocated to furnish and install sensor(s) and devices for the monitoring of Unitary Device Spaces Space Relative Humidity condition.

- IHHS Alternate 2: Add Co2 Sensors / DCV to existing Units
  - Cafeteria (3-AHUs)
  - Main Gym (1-AHU)
  - Aux Gym (1-HV-RTU)
  - Auditorium (2-AHUs)

D. Alternates Excluded: (RTU Replacement and Split System Replacement Scope)

If Ramapo Indian Hills Regional High School District adds ECM 6 & ECM 7 the following will also be included:

IHHS Rooftop Unit Replacement – Rooftop Unit Controls

- (15) ROOF TOP AND AIR HANDLING UNITS

- Furnish and install controls and devices for (15) Roof Top Unit(s) Natural Gas or Hot Water Heating / Direct Expansion Cooling (as scheduled), (3) VAV Box Control(s) and (2) Duct Heating Coil control(s)

- The Roof Top Unit(s) shall be furnished by other(s), DDC Ready, (i.e., damper actuator, relays, transformer etc.).

- Furnish and install New Niagara 4 DDC Controller, wall sensor(s) (Reuse the existing wall sensor wiring) and heating valve control wiring. Connection of communication(s) network connection to the Roof Top Unit. The existing interlock wiring and any existing Duct Heater Coil or Fintube Radiation control valve shall be reconnected to the RTU's new Niagara 4 DDC controller.

- Control Points The control points which are typical of a new Roof Top Unit are:
    - Occupancy Schedule (BV)
    - Min. Outside Air Damper Setpoint (AV)
    - Min. Discharge Air Temp. Setpoint (AV)
    - Global Outside Air Temperature (AV)
    - Supply Fan Low / Med / High (BO x 3) or
    - Speed signal (AO)
    - Unit Fan Status (BI)
    - Space Temperature (AI) w/ local setpoint
    - Occupied Space Heating Setpoint (AV)
    - Occupied Space Cooling Setpoint (AV)
    - Un-Occupied Space Heating Setpoint (AV)
    - Un-Occupied Space Cooling Setpoint (AV)
    - Space Relative Humidity (AI)
    - Discharge Air Temperature (AI)
    - Return Air Temperature (AI)
    - Mixed Air Temperature (AI)
    - Low-Limit Temperature Switch (BI)

- Filter Status (BV)
- Heating Control Valve or Stage (AO)/(BO)
- Fintube Radiation Valve (BO) (where existing)
- Cooling Stage signal (BOx2)
- Exh. Fan Start/Stop (BO) (where existing)
- Economizer Damper signal (AO)
- Cooling Lockout
- Heating Lockout
- CO2 Sensor

- Existing Duct Heater Control (associated with Roof Top Unit(s))
  - The new Johnson Niagara 4 Roof Top Unit DDC controller shall be designed to incorporate the existing control of their associated Duct Heating Coil(s), (i.e., Analog or Binary, Inputs and Outputs)
  - Furnish and install new space temperature sensor(s) with local setpoint control and connect the existing hot water control valve wiring to the New Roof Top Unit DDC controller
  - Typical Duct Heater Coil control points: Heating Coil Control valve signal - AO Space temperature w/ local setpoint - AI

- IHHS Add Alternate 1-1: CO2 sensors with demand control ventilation in large spaces Add (9) CO2 sensor(s) to RTU-01, RTU-02, RTU-04, RTU-05, AC-3, RTU-08, RTU-10, RTU-20, RTU-21

- IHHS Add Alternate 1-2: Provide controls and installation for (3) Daikin Units RTU-1 – Nurse (Daikin) RTU-2 – Conference Room (Daikin) RTU-5 – 600 & 803 (Daikin)

IHHS Split System Replacement – Split System Controls

- Split System Air Conditioning Units
  - AC SS – 974
  - CACCU-01
  - CACCU-02
  - AHUCU-02
  - ACCU01
  - ACCU02
  - ACCU-03

- AHUCU01
- CU-1
- CU-02

- Furnish and install controls and devices for (8) Split System Air Conditioning Unit(s)(SSAC) and (2) Condensing Unit(s)

- The SSAC Unit(s) shall be furnished by other(s) and shall incorporate any internal safety device(s) (i.e., high low-pressure cutouts, oat lockouts etc.)

- Furnish and install New Niagara 4 DDC Controller, wall sensor(s) (Reuse the existing wall sensor wiring). Connection of communication(s) network connection to the SSAC Unit.

- The control points which are typical of a new Split System Air Conditioning Unit(s) are:
    - Occupancy Schedule (BV)
    - Global Outside Air Temperature (AV)
    - Supply Fan Start/Stop
    - Unit Fan Status (BI)
    - Space Temperature (AI) w/ local setpoint
    - Occupied Space Cooling Setpoint (AV)
    - Un-Occupied Space Cooling Setpoint (AV)
    - Discharge Air Temperature (AI)
    - Filter Status (BV)
    - Cooling Stage signal (BOx2)

ECM Calculations

Energy savings from upgrading the district Energy Management System were calculated using the BPU protocols. The upgraded system will have improved and precise occupied/unoccupied scheduling capabilities programed through user interface at a central computer dashboard. The proposed controls maintain the heating occupied setpoint of 70F during occupied hours and 68F setpoint during unoccupied hours and cooling occupied setpoint of 72F during occupied hours and 74F setpoint during unoccupied hours. To be conservative with savings estimates, DCO is claiming savings on 2F setback temperatures during unoccupied hours – typically setbacks greater than 2F are achievable. Demand Control Ventilation energy savings for the specific units reflected in the scope of work are calculated using BPU Protocols based off and ASHRAE STANDARD 62.1 -2016 calculated outdoor air rates. The calculations are shown below.

CALCULATED SAVINGS

EMS Savings

BUILDING	Unit Type	Weekly Occupied Hours [H]	RTU Cooling (tons) [CAPrtu]	RTU Cooling Efficiency (EER) [EERrtu]	RTU Heating (Btu/hr) [CAPrtu]	RTU Heating Efficiency (%) [AFUEh]	Boiler Heating (Btu/hr) [CAPboiler]	Boiler Heating Efficiency (%) [AFUEh]
Ramapo High School	Boiler	70					12,000,000	87.0%
Ramapo High School	Rooftop Units (DX-Gas Fired)	70	516.5	8.4	8,943,000	75.7%		
Ramapo High School	Rooftop Units (DX)	70	37.0	11.3				
Ramapo High School	Condensing Units	70						
Ramapo High School	Split System - Heat Pump	70						
Ramapo High School								
Indian Hills High School	Boiler	70					12,000,000	84.9%
Indian Hills High School	Rooftop Units (DX-Gas Fired)	70	308.0	8.40	6,603,000	76.4%		
Indian Hills High School	Condensing Units	70	83.5	9.67				
Indian Hills High School	Split System - Heat Pump	70						
Indian Hills High School								

EMS Savings

BUILDING	Unit Type	Weekly Occupied Hours [H]	ELFHc	ELFHh	RTU Cooling Energy Savings (kWh)	RTU Heating Energy Savings (therms)	Boiler Heating Energy Savings (therms)	Total Electric Savings (kWh)	Total Gas Savings (therms)
Ramapo High School	Boiler	70	466	901	0	0	4,128	0	4,128
Ramapo High School	Rooftop Units (DX-Gas Fired)	70	466	901	22,840	3,537	0	22,840	3,537
Ramapo High School	Rooftop Units (DX)	70	466	901	1,214	0	0	1,214	0
Ramapo High School	Condensing Units	70	466	901	0	0	0	0	0
Ramapo High School	Split System - Heat Pump	70	466	901	0	0	0	0	0
Ramapo High School					0	0	0	0	0
Indian Hills High School	Boiler	70	466	901	0	0	4,230	0	4,230
Indian Hills High School	Rooftop Units (DX-Gas Fired)	70	466	901	13,622	2,587	0	13,622	2,587
Indian Hills High School	Condensing Units	70	466	901	3,207	0	0	3,207	0
Indian Hills High School	Split System - Heat Pump	70	466	901	0	0	0	0	0
Indian Hills High School					0	0	0	0	0

EMS Savings						
BUILDING	SQFT	Unit Type	Existing Control Type	Weekly Occupied Hours [H]	Total Electric Savings (kWh)	Total Gas Savings (therms)
Ramapo High School	241,600	Boiler	Digital - Platform	70	24,053	7,665
Ramapo High School		Rooftop Units (DX-Gas Fired)	Digital - Platform	70		
Ramapo High School		Rooftop Units (DX)	Digital - Platform	70		
Ramapo High School		Condensing Units	Digital - Platform	70		
Ramapo High School		Split System - Heat Pump	Digital - Platform	70		
Ramapo High School			Digital - Platform			
Indian Hills High School	240,320	Boiler	Digital - Platform	70	16,829	6,817
Indian Hills High School		Rooftop Units (DX-Gas Fired)	Digital - Platform	70		
Indian Hills High School		Condensing Units	Digital - Platform	70		
Indian Hills High School		Split System - Heat Pump	Digital - Platform	70		
Indian Hills High School			Digital - Platform			

Occupancy Controlled Thermostat Savings Calculation	
Th (F)	70
Tc (F)	72
Sh (F)	68
Sc (F)	74
H (hrs per week)	Varies
EFLHc (hrs per year)	Varies
EFLHh (hrs per year)	Varies
Ph (%)	3%
Pc (%)	6%

<u>NJ BPU FY 2020 Protocols - Occupancy Controlled Thermostats</u>

Algorithms

Cooling Energy Savings (kWh/yr) = $(((T_c * (H+5) + S_c * (168 - (H+5)))/168) - T_c) * (P_c * Cap_{hp} * 12 * EFLH_c/EER_{hp})$

Heating Energy Savings (kWh/yr) = $(T_h - ((T_h * (H+5) + S_h * (168 - (H+5)))/168)) * (P_h * Cap_{hp} * 12 * EFLH_h/EER_{hp})$

Heating Energy Savings (Therms/yr) = $(T_h - ((T_h * (H+5) + S_h * (168 - (H+5)))/168) * (P_h * Cap_h * EFLH_h/AFUE_h/100{,}000)$

Definition of Variables

T_h = Heating Season Facility Temp. (°F)
T_c = Cooling Season Facility Temp. (°F)
S_h = Heating Season Setback Temp. (°F)
S_c = Cooling Season Setup Temp. (°F)
H = Weekly Occupied Hours
Cap_{hp} = Connected load capacity of heat pump/AC (Tons) – Provided on Application.
Cap_h = Connected heating load capacity (Btu/hr) – Provided on Application.
$EFLH_c$ = Equivalent full load cooling hours
$EFLH_h$ = Equivalent full load heating hours
P_h = Heating season percent savings per degree setback
P_c = Cooling season percent savings per degree setup
$AFUE_h$ = Heating equipment efficiency – Provided on Application.
EER_{hp} = Heat pump/AC equipment efficiency – Provided on Application

12	= Conversion factor from Tons to kBtu/hr to acquire consumption in kWh.
168	= Hours per week.
7	= Assumed weekly hours for setback/setup adjustment period (based on 1 setback/setup per day, 7 days per week).

Summary of Inputs

Occupancy Controlled Thermostats

Component	Type	Value	Source
T_h	Variable		Application
T_c	Variable		Application
S_h	Fixed	T_h-5°	
S_c	Fixed	T_c+5°	
H	Variable		Application; Default of 84 hrs/week
Cap_{hp}	Variable		Application
Cap_h	Variable		Application
$EFLH_{c,h}$	Variable	See Table Below	1
P_h	Fixed	3%	2
P_c	Fixed	6%	2
$AFUE_h$	Variable		Application
EER_{hp}	Variable		Application

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Cooling	507	550	562
Low-rise, Heating	757	723	503
High-rise, Cooling	793	843	954
High-rise, Heating	526	395	219

CALCULATED SAVINGS

Demand Control Ventilation Savings

BUILDING	Ventilation SQFT	Componet	HVAC Unit #	People Outdoor Air Rate (cfm/person)	Area Outdoor Air Rate (cfm/sqft)	Occupant Density (#/1000 sqft)	Combined Outdoor Air Rate (cfm/person)	Total Occupants
Ramapo High School	10,000	Auditorium	RTU-1A	5	0.06	150	5.4	1,500
	6,000	Cafeteria	RTU-2N	7.5	0.18	100	9.3	600
	10,900	Main Gym	HV-3D / HV-4D	20	0.18	7	45.7	77
	7,000	Lower Gym	AHU-1 / AHU-2	20	0.18	7	45.7	49
Indian Hills High School	11,500	Auditorium	AHU-1 / CU-1	5	0.06	150	5.4	1,725
	5,000	Cafeteria	AHU-1	7.5	0.18	100	9.3	500
	10,000	Gym	HV-1	20	0.18	7	45.7	70
	5,600	Lower Gym	RTU-3	20	0.18	7	45.7	40

Demand Control Ventilation Savings

BUILDING	Ventilation SQFT	Componet	HVAC Unit #	Calculated OA (cfm)	Existing Design OA (cfm)	CESF	CDSF	HSF	DCV Electric Savings (kWh)	DCV Demand Savings (kW)	DCV Gas Savings (Th)	Total Electric Savings (kWh)	Total Demand Savings (kW)	Total Gas Savings (Th)
Ramapo High School	10,000	Auditorium	RTU-1A	8,100	5,160	1.500	0.0015	0.043	7,740	8	2,219	7,740	8	11,239
	6,000	Cafeteria	RTU-2N	5,580	N/A			0.072	0	0	4,018			
	10,900	Main Gym	HV-3D / HV-4D	3,502	5,250			0.069	0	0	3,623			
	7,000	Lower Gym	AHU-1 / AHU-2	2,240	2,000			0.069	0	0	1,380			
Indian Hills High School	11,500	Auditorium	AHU-1 / CU-1	9,315	N/A	1.500	0.0015	0.043	13,973	14	4,005	13,973	14	9,840
	5,000	Cafeteria	AHU-1	4,650	3,600			0.072	0	0	2,592			
	10,000	Gym	HV-1	3,200	N/A			0.069	0	0	2,208			
	5,600	Lower Gym	RTU-3	1,808	1,500			0.069	0	0	1,035			

All Calculated Outdoor Air Rates refence ANSI ASHRAE STANDARD 62.1 -2016

NJ BPU FY 2020 Protocols – Demand Control Ventilation

Algorithms

Energy Savings (kWh/yr) = CESF * CFM

Peak Demand Savings (kW) = CDSF * CFM

Fuel Savings (MMBtu/yr) = HSF * CFM

Definition of Variables

CESF = Cooling Energy Savings Factor (kWh/CFM)

CDSF = Cooling Demand Savings Factor (kW/CFM)

HSF = Heating Savings Factor (MMBtu/CFM)

CFM = Baseline Design Ventilation Rate of Controlled Space (CFM)

Summary of Inputs

Demand Controlled Ventilation Using CO_2 SensorsComponent	Type	Value	Source
CESF	Fixed	0.0484 MMBtu/CFM See Table 2	1

Demand Controlled Ventilation Using CO_2 SensorsComponent	Type	Value	Source
CDSF	Fixed		1
HSF	Fixed		1
CFM	Variable		Application

Savings Factors for Demand-Controlled Ventilation Using CO_2 Sensors

Component	CESF	CDSF	HSF
Assembly	2.720	0.0014	0.074
Auditorium – Community Center	1.500	0.0015	0.043
Gymnasium	2.558	0.0013	0.069
Office Building	2.544	0.0013	0.068
Elementary School	1.079	0.0013	0.029
High School	2.529	0.0015	0.072
Shopping Center	1.934	0.0012	0.050
Other	2.544	0.0013	0.068

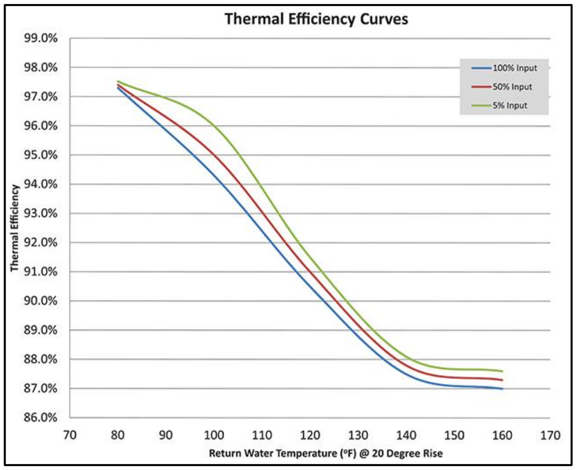
ECM 4 – Boiler Replacement

RAMAPO INDIAN HILLS RHSD

✔	ECM evaluated but not included
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
4	Boiler Replacement	✔	

Old, oversized boiler systems have efficiencies in the range of 56%–75%. A condensing boiler hot water heating system can achieve efficiencies as high as 97%, converting nearly all the fuel to useful heat. The efficiency of the boiler increases at lower return water temperature. Lower return water temperatures allow more water vapor from the exiting flue gas to condense, allowing its latent heat of vaporization to be recovered.



Existing Conditions

Ramapo High School – Ten (10) 1810 MBh A.O. Smith non-condensing boilers served the hot water loop for heating to the entire school. The district was having on-going maintenance issues every heating season while these boilers were reaching the end of their useful life. DCO Energy witnessed during the investment grade audit, in the summer of 2022, the district began the removal process of this boiler plant. RIHRHSD plans to have the new boiler plant up and ready for the upcoming heating season (October). DCO Energy will be claiming the energy savings associated with the boiler replacement within RIHRHSD's ESIP project.

Hot water boilers before replacement at Ramapo High School

Scope of Work

All boilers are currently in the process of being replaced by the district for the 2022-2023 school year. DCO will be capturing energy savings from the boiler replacement within this ESIP project.

Ramapo High School

- Remove (10) existing 1810 MBH hot water boilers
- Install (4) 4000 MBH condensing hot water boilers
- Heating Hot Water and Electrical tie-in
- Building Automation System integration

ECM Calculations

Energy Savings from the installation of a high efficiency boilers were calculated using the BPU protocols. Existing hot water boiler efficiency is derated 81.6% at Ramapo High School based on age and condition. The proposed high efficiency hot water boilers are minimum of 87% efficient.

CALCULATED SAVINGS

Boiler Replacement Savings						
BUILDING	Existing Qty	Exitsting Qty Used	Input Capacity (mbh) [CAPin]	Equivalent Full Load Hours [EFLHh]	Boiler Baseline Efficiency [EFFb]	Baseline Plant Rated Output MBH
Ramapo High School	10	7	12,670	901	81.6%	10,333

Boiler Replacement Savings							
BUILDING	Proposed Qty	Proposed Qty Used	Boiler Proposed Efficiency [EFFq]	Proposed Plant Rated Input MBH (CAPYbi)	Qualifying Boiler Efficiency (EFFq)	Proposed Plant Rated Output MBH	Calculated Annual Fuel Savings (Th)
Ramapo High School	4	3	87%	12,000	87%	10,440	7,620

Algorithms

Fuel Savings (MMBtu/yr) = Cap_{in} * $EFLH_h$ * ((Eff_q/Eff_b)-1) / 1000 kBtu/MMBtu

Definition of Variables

Cap_{in} = Input capacity of qualifying unit in kBtu/hr

$EFLH_h$ = The Equivalent Full Load Hours of operation for the average unit during the heating season in hours

Eff_b = Boiler Baseline Efficiency

Eff_q = Boiler Proposed Efficiency

1000 = Conversion from kBtu to MMBtu

Summary of Inputs

Prescriptive Boilers

Component	Type	Value	Source
Cap_{in}	Variable		Application
$EFLH_h$	Fixed	See Table Below	1
Eff_b	Variable	See Table Below	2
Eff_q	Variable		Application

$EFLH_h$ Table

Facility Type	Heating EFLH
Assembly	603
Auto repair	1910
Dormitory	465
Hospital	3366
Light industrial	714
Lodging – Hotel	1077
Lodging – Motel	619
Office – large	2034
Office – small	431
Other	681
Religious worship	722

Facility Type	Heating EFLH
Restaurant – fast food	813
Restaurant – full service	821
Retail – big box	191
Retail – Grocery	191
Retail – small	545
Retail – large	2101
School – Community college	1431
School – postsecondary	1191
School – primary	840
School – secondary	901
Warehouse	452

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Heating	757	723	503
High-rise, Heating	526	395	219

Baseline Boiler Efficiencies (Eff_b)

Boiler Type	Size Category (kBtu input)	Standard 90.1-2016
Hot Water – Gas fired	< 300 ≥ 300 and ≤ 2,500 > 2,500	82% AFUE 80% Et 82% Ec
Hot Water – Oil fired	< 300 ≥ 300 and ≤ 2,500 > 2,500	84% AFUE 82% Et 84% Ec
Steam – Gas fired	< 300	80% AFUE
Steam – Gas fired, all except natural draft	≥ 300 and ≤ 2,500	79% Et
Steam – Gas fired, all except	> 2,500	79% Ec

Boiler Type	Size Category (kBtu input)	Standard 90.1-2016
Steam – Gas fired, natural draft	≥ 300 and ≤ 2,500	79% Et
Steam – Gas fired, natural draft	> 2,500	79% Ec
Steam – Oil fired	< 300 ≥ 300 and ≤ 2,500 > 2,500	82% AFUE 81% Et 81% Ec

Sources

1. New York State Joint Utilities, *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs*, V7, April 2019. Appendix G – Equivalent Full-Load Hours (EFLH), For Heating and Cooling. P. 675-680. EFLH values for NYC due to proximity to NJ.
2. ASHRAE Standards 90.1-2016. *Energy Standard for Buildings Except Low Rise Residential Buildings*; available at: https://www.ashrae.org/standards-research--technology/standards--guidelines. Table 6.8.1-6

ECM 5 – Premium Efficiency Pump Motors and VFDs

RAMAPO INDIAN HILLS RHSD

✓	ECM evaluated but not included
✓	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
5	Premium Efficiency Pump Motors and VFDs	✓	

Premium efficiency electric motors will help optimize fan and pump efficiency, reduce electrical power consumption, and improve system reliability. These motors are designed to run cooler, last longer, and require less maintenance than the existing standard efficiency motors. Premium efficiency motors can be as high as 95% efficient (as opposed to standard efficiency motors of 78% to 88%) and are capable of operating at varying speeds allowing Variable Frequency Drive (VFD) installations where applicable.

Existing Conditions

Ramapo High School – RIHRHSD has undergone hot water plant upgrades at Ramapo High School. Four (4) hot water loop pumps, (2) 60HP and (2) 15HP were removed during the Summer of 2022. The 60HP pumps which were removed also had VFDs. The district has installed all new pumps, motors to reflect in-kind capacity replacement with both sets of pumps having VFDs installed. The hot water loop pumps will be in operation once the upcoming heating season starts, likely October of 2022. DCO Energy is claiming energy savings regarding these pump replacements with VFD installation the district has implemented outside of the ESIP program.

Hot Water Pumps before replacement at Ramapo High School

Scope of Work

Pump + VFD Estimate				
BUILDING	CATEGORY	QUANTITY	HP	Notes
Ramapo High School	HWLP-1-2	2	60.0	Pump and Motor Replacement conducted outside ESIP by RIHRSD
	HWLP-3-4	2	15.0	

Ramapo High School - The four (4) constant volume hot water loop pumps at Ramapo high School will be replaced with new pumps, motors. VFDs will be added to HWLP 3 and 4. The district is currently in the process of upgrading to premium efficiency pump motors and VFDs for the 2022-2023 school year. DCO will be capturing the savings from these replacements.

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

ECM Calculations

Energy Savings from the installation of premium efficiency pump motors and VFDs were calculated using BPU protocols. The calculations are shown below.

CALCULATED SAVINGS

Pump + VFD Savings

BUILDING	SYSTEM AND SERVICE	QTY	OPERATIONAL QTY	MOTOR HP	EXISTING MOTOR EFFICIENCY (Nbase)	REPLACEMENT MOTOR EFFICIENCY (Nprem)
Ramapo High School	HWLP-1-2	2	1	60	91.7%	95.0%
	HWLP-3-4	2	1	15	91.7%	93.0%

Pump + VFD Savings

BUILDING	LF	CF	IFvfd	HRS	ΔkW	PREM. MOTOR DEMAND SAVINGS (kW)	PREM. MOTOR ELECTRIC SAVINGS (kWh)	VFD ESF	VFD DSF
Ramapo High School	0.75	0.74	0.9	5329	1.53	1.13	6,099		
	0.75	0.74	1.0	2745	0.17	0.13	351	1,548	0.096

Pump + VFD Savings

BUILDING	VFD DEMAND SAVINGS (kW)	VFD ELECTRIC SAVINGS (kWh)	TOTAL DEMAND SAVINGS (kW)	TOTAL DEMAND SAVINGS (kW)	TOTAL ELECTRIC SAVINGS (kWh)	TOTAL ELECTRIC SAVINGS (kWh)
Ramapo High School	0.00	0	1.13	2.70	6,099	29,670
	1.44	23,220	1.57		23,571	

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
LF	Fixed	0.75	1
η_{base}	Fixed	ASHRAE 90.1-2016 Baseline Efficiency Table	ASHRAE
η_{prem}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
IF_{VFD}	Fixed	1.0 or 0.9	3
Efficiency - η_{ee}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
CF	Fixed	0.74	1
HRS	Fixed	Annual Operating Hours Table	1

NEMA ASHRAE 90.1-2016 Motor Efficiency Table – General Purpose Subtype I (Adapted from Table 10.8-1)

Motor Horsepower	1200 RPM (6 pole)		1800 RPM (4 pole)		3600 RPM (2 pole)	
	ODP	TEFC	ODP	TEFC	ODP	TEFC
1	.825	.825	.855	.855	.77	.77
1.5	.865	.875	.865	.865	.84	.84
2	.875	.885	.865	.865	.855	.855
3	.885	.895	.895	.895	.855	.865
5	.895	.895	.895	.895	.865	.885
7.5	.902	.91	.91	.917	.885	.895
10	.917	.91	.917	.917	.895	.902
15	.917	.917	.93	.924	.902	.91
20	.924	.917	.93	.930	.91	.91
25	.93	.93	.936	.936	.917	.917
30	.936	.93	.941	.936	.917	.917
40	.941	.941	.941	.941	.924	.924
50	.941	.941	.945	.945	.93	.93
60	.945	.945	.95	.950	.936	.936
75	.945	.945	.95	.954	.936	.936
100	.95	.95	.954	.954	.936	.941
125	.95	.95	.954	.954	.941	.95
150	.954	.958	.958	.958	.941	.95
200	.954	.958	.958	.962	.95	.954

Annual Operating Hours Table

Motor Horsepower	Operating Hours, HRS
1 to 5 HP	2,745
6 to 20 HP	3,391
21 to 50 HP	4,067
51 to 100 HP	5,329
101 to 200 HP	5,200

Algorithms

From application form calculate ΔkW where:

$$\Delta kW = 0.746 * HP * IF_{VFD} * (1/\eta_{base} - 1/\eta_{prem})$$

Demand Savings = (ΔkW) * CF

Energy Savings = (ΔkW)*HRS * LF

Definition of Variables

ΔkW = kW Savings at full load
HP = Rated horsepower of qualifying motor, from nameplate/manufacturer specs.
LF = Load Factor, percent of full load at typical operating condition
IF_{VFD} = VFD Interaction Factor, 1.0 without VFD, 0.9 with VFD
η_{base} = Efficiency of the baseline motor
η_{prem} = Efficiency of the energy-efficient motor
HRS = Annual operating hours
CF = Coincidence Factor

Algorithms

Energy Savings (kWh/yr) = N * HP * ESF

Peak Demand Savings (kW) = N * HP * DSF

Definitions of Variables

N = Number of motors controlled by VFD(s) per application
HP = Nameplate motor horsepower or manufacturer specification sheet per application
ESF = Energy Savings Factor (kWh/year per HP)
DSF = Demand Savings Factor (kW per HP)

Summary of Inputs

Variable Frequency Drives

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
ESF	Variable	See Table Below	Derived value based on the following sources: 1, 2, 3
DSF	Variable	See Table Below	Derived value based on the following sources: 1, 2, 3

The ESF for the supply and return fans and circulating pumps are derived from a 2014 NEEP-funded study of 400 VFD installations in eight northeast states. The derived values are based on actual logged input power data and reflect average operating hours, load factors, and motor efficiencies for the sample. Savings factors representing cooling tower fans and boiler feed water pumps are not reflected in the NEEP report. Values representing these applications are taken from April 2018 New York TRM, Appendix K, and represent average values derived from DOE2.2 simulation of various building types

VFD Savings Factors

Application	ESF (kWh/Year-HP)	DSF (kW/HP)	Source
Supply Air Fan	2,033	0.286	1
Return Air Fan	1,788	0.297	1
CHW or CW Pump	1,633	0.185	1
HHW Pump	1,548	0.096	1
WSHP Pump	2,562	0.234	1
CT Fan	290	-0.025	2, 3
Boiler Feedwater Pump	1,588	0.498	2, 3

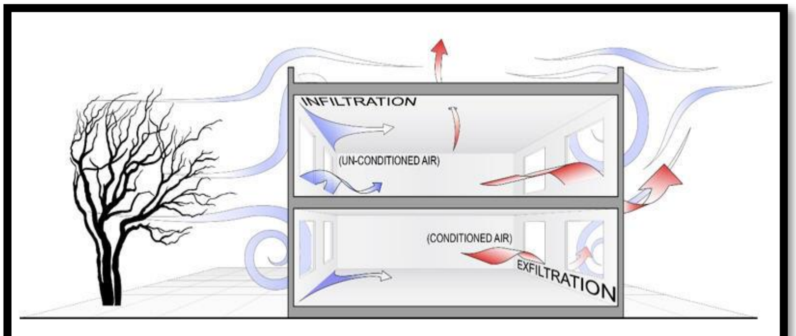
ECM 8 – Building Envelope Weatherization

RAMAPO INDIAN HILLS RHSD

✓	ECM evaluated but not included
✓	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
8	Building Envelope Weatherization	✓	✓

An on-site survey of the existing air barrier continuity was conducted at all eight Ramapo Indian Hills Regional High School District buildings. During the on-site inspection, several areas of the facilities were inspected for effective air barriers at the building envelope. Temperature, relative humidity, CO2 levels, smoke pencil testing and Infrared imaging was used to determine areas of uncontrolled air leakage into and out of the buildings.



Infiltration is unconditioned air that enters the building from a variety of paths.

Each of these facilities had varying degrees of uncontrolled air leakage into and out of the buildings. Typically, the exterior doors were found to have failed, missing or worn weather-seals and in some cases the exterior caulking had failed. Many of the facilities had insulation materials installed at the exterior roof/wall intersections. This can increase thermal values, however, the air leakage around the insulation and through the roof/wall joint was significant and results in increased energy costs.

Existing Conditions


Existing Conditions at Ramapo HS and Indian Hills HS

Scope of Work

Building Envelope Scope Of Work					
BUILDING	SQFT	Type	CATEGORY	UNITS	QUANTITY
Ramapo High School	241,600	Door Weather Stripping	Double Door - Sides, Sweep (UT)	UT	2
			Double Door - Sides, Sweep, Center (UT)	UT	18
			Double Door - Sides, Top, Sweep, Center (UT)	UT	3
			Double Door - Sweep, Center (UT)	UT	2
			Install Door Jamb Spacer (UT)	UT	1
			Single Door - Sides, Sweep (UT)	UT	30
			Single Door - Sides, Top, Sweep (UT)	UT	8
			Single Door - Sweep (UT)	UT	2
		Overhand Air Sealing	Block, Seal (SF)	SF	32
		Roof-Wall Intersection Air Sealing	Block, Seal (LF)	LF	687
			Block, Seal Paint (LF)	LF	44
			Seal (LF)	LF	1,620
			Seal Exposed (LF)	LF	32
			Seal Paint (LF)	LF	71

Building Envelope Scope Of Work					
BUILDING	SQFT	Type	CATEGORY	UNITS	QUANTITY
Indian Hills High School	240,320	Buck Frame Air Sealing	Seal (LF)	LF	354
			Seal Exposed (LF)	LF	316
		Caulking	Interior Seal Oversized (LF)	LF	50
		Door Weather Stripping	Double Door - Sides, Center (UT)	UT	1
			Double Door - Sides, Sweep (UT)	UT	7
			Double Door - Sides, Sweep, Center (UT)	UT	24
			Double Door - Sides, Top, Sweep (UT)	UT	2
			Double Door - Sides, Top, Sweep, Center (UT)	UT	9
			Double Door - Sweep, Center (UT)	UT	4
			Single Door - Sides, Sweep (UT)	UT	8
			Single Door - Sides, Top, Sweep (UT)	UT	3
		Overhang Air Sealing	Seal (LF)	LF	778
		Roof-Wall Intersection Air Sealing	Block, Seal (LF)	LF	73
			Block, Seal Paint (LF)	LF	396
			Seal (LF)	LF	150
			Seal Exposed (LF)	LF	44
			Seal Paint (LF)	LF	752
		Wall Air Sealing	Block, Seal (SF)	SF	1
			Block, Seal Exposed (UT)	UT	0

Building Envelope improvements to the district will included and not limited to:

- Door weather Stripping
- Roof-Wall Intersection Air Sealing
- Overhang Air Sealing
- Caulking
- Buck Frame Air Sealing
- Attic Insulation
- Attic Bypass Air Sealing

- Weather strip and insulate the attic hatch to provide an airtight seal with permanently fixed insulation to prevent thermal heat gain and loss consistent with the surrounding attic recommendations.

ECM Calculations

Energy Savings from the installation of building envelope improvements are calculated on the following pages:

CALCULATED SAVINGS						
Building Envelope - Heating Savings						
BUILDING	**TYPE**	**SUBTYPE**	**INFILTRATION REDUCTION (CFM)**	**HEATING FUEL**	**HEATING EFFICIENCY (%)**	**SENSIABLE HEAT CONSTANT**
Ramapo High School	Door Weather Stripping	Double Door - Sides, Sweep (UT)	47	Natural Gas	87.0%	1.08
Ramapo High School	Door Weather Stripping	Double Door - Sides, Sweep, Center (UT)	569	Natural Gas	87.0%	1.08
Ramapo High School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	116	Natural Gas	87.0%	1.08
Ramapo High School	Door Weather Stripping	Double Door - Sweep, Center (UT)	30	Natural Gas	87.0%	1.08
Ramapo High School	Door Weather Stripping	Install Door Jamb Spacer (UT)	0	Natural Gas	87.0%	1.08
Ramapo High School	Door Weather Stripping	Single Door - Sides, Sweep (UT)	597	Natural Gas	87.0%	1.08
Ramapo High School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	187	Natural Gas	87.0%	1.08
Ramapo High School	Door Weather Stripping	Single Door - Sweep (UT)	7	Natural Gas	87.0%	1.08
Ramapo High School	Overhand Air Sealing	Block, Seal (SF)	25	Natural Gas	87.0%	1.08
Ramapo High School	Roof-Wall Intersection Air Sealing	Block, Seal (LF)	804	Natural Gas	87.0%	1.08
Ramapo High School	Roof-Wall Intersection Air Sealing	Block, Seal Paint (LF)	51	Natural Gas	87.0%	1.08
Ramapo High School	Roof-Wall Intersection Air Sealing	Seal (LF)	1,264	Natural Gas	87.0%	1.08
Ramapo High School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	25	Natural Gas	87.0%	1.08
Ramapo High School	Roof-Wall Intersection Air Sealing	Seal Paint (LF)	56	Natural Gas	87.0%	1.08
Indian Hills High School	Buck Frame Air Sealing	Seal (LF)	184	Natural Gas	84.9%	1.08
Indian Hills High School	Buck Frame Air Sealing	Seal Exposed (LF)	164	Natural Gas	84.9%	1.08
Indian Hills High School	Caulking	Interior Seal Oversized (LF)	15	Natural Gas	84.9%	1.08
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Center (UT)	25	Natural Gas	84.9%	1.08
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Sweep (UT)	164	Natural Gas	84.9%	1.08
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Sweep, Center (UT)	758	Natural Gas	84.9%	1.08
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Top, Sweep (UT)	61	Natural Gas	84.9%	1.08
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	348	Natural Gas	84.9%	1.08
Indian Hills High School	Door Weather Stripping	Double Door - Sweep, Center (UT)	61	Natural Gas	84.9%	1.08
Indian Hills High School	Door Weather Stripping	Single Door - Sides, Sweep (UT)	159	Natural Gas	84.9%	1.08
Indian Hills High School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	70	Natural Gas	84.9%	1.08
Indian Hills High School	Overhang Air Sealing	Seal (LF)	31	Natural Gas	84.9%	1.08
Indian Hills High School	Roof-Wall Intersection Air Sealing	Block, Seal (LF)	911	Natural Gas	84.9%	1.08
Indian Hills High School	Roof-Wall Intersection Air Sealing	Block, Seal Paint (LF)	85	Natural Gas	84.9%	1.08
Indian Hills High School	Roof-Wall Intersection Air Sealing	Seal (LF)	309	Natural Gas	84.9%	1.08
Indian Hills High School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	117	Natural Gas	84.9%	1.08
Indian Hills High School	Roof-Wall Intersection Air Sealing	Seal Paint (LF)	35	Natural Gas	84.9%	1.08
Indian Hills High School	Wall Air Sealing	Block, Seal (SF)	440	Natural Gas	84.9%	1.08
Indian Hills High School	Wall Air Sealing	Block, Seal Exposed (UT)	4	Natural Gas	84.9%	1.08

Building Envelope - Heating Savings							
BUILDING	TYPE	SUBTYPE	HOURS (HR/DAY)	HEAT EFFICIENCY FACTOR	HEATING DEGREE DAYS	INFILTRATION HEATING SAVINGS (THERM)	TOTAL HEATING SAVINGS (THERM)
Ramapo High School	Door Weather Stripping	Double Door - Sides, Sweep (UT)	24	3356	4701	66	66
Ramapo High School	Door Weather Stripping	Double Door - Sides, Sweep, Center (UT)	24	3356	4701	797	797
Ramapo High School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	24	3356	4701	162	162
Ramapo High School	Door Weather Stripping	Double Door - Sweep, Center (UT)	24	3356	4701	43	43
Ramapo High School	Door Weather Stripping	Install Door Jamb Spacer (UT)	24	3356	4701	0	0
Ramapo High School	Door Weather Stripping	Single Door - Sides, Sweep (UT)	24	3356	4701	836	836
Ramapo High School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	24	3356	4701	262	262
Ramapo High School	Door Weather Stripping	Single Door - Sweep (UT)	24	3356	4701	10	10
Ramapo High School	Overhand Air Sealing	Block, Seal (SF)	24	3356	4701	35	35
Ramapo High School	Roof-Wall Intersection Air Sealing	Block, Seal (LF)	24	3356	4701	1126	1,126
Ramapo High School	Roof-Wall Intersection Air Sealing	Block, Seal Paint (LF)	24	3356	4701	72	72
Ramapo High School	Roof-Wall Intersection Air Sealing	Seal (LF)	24	3356	4701	1770	1,770
Ramapo High School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	24	3356	4701	35	35
Ramapo High School	Roof-Wall Intersection Air Sealing	Seal Paint (LF)	24	3356	4701	78	78
Indian Hills High School	Buck Frame Air Sealing	Seal (LF)	24	3275	4701	264	264
Indian Hills High School	Buck Frame Air Sealing	Seal Exposed (LF)	24	3275	4701	236	236
Indian Hills High School	Caulking	Interior Seal Oversized (LF)	24	3275	4701	21	21
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Center (UT)	24	3275	4701	35	35
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Sweep (UT)	24	3275	4701	235	235
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Sweep, Center (UT)	24	3275	4701	1089	1,089
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Top, Sweep (UT)	24	3275	4701	87	87
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	24	3275	4701	499	499
Indian Hills High School	Door Weather Stripping	Double Door - Sweep, Center (UT)	24	3275	4701	87	87
Indian Hills High School	Door Weather Stripping	Single Door - Sides, Sweep (UT)	24	3275	4701	228	228
Indian Hills High School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	24	3275	4701	101	101
Indian Hills High School	Overhang Air Sealing	Seal (LF)	24	3275	4701	44	44
Indian Hills High School	Roof-Wall Intersection Air Sealing	Block, Seal (LF)	24	3275	4701	1308	1308
Indian Hills High School	Roof-Wall Intersection Air Sealing	Block, Seal Paint (LF)	24	3275	4701	122	122
Indian Hills High School	Roof-Wall Intersection Air Sealing	Seal (LF)	24	3275	4701	443	443
Indian Hills High School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	24	3275	4701	168	168
Indian Hills High School	Roof-Wall Intersection Air Sealing	Seal Paint (LF)	24	3275	4701	50	50
Indian Hills High School	Wall Air Sealing	Block, Seal (SF)	24	3275	4701	632	632
Indian Hills High School	Wall Air Sealing	Block, Seal Exposed (UT)	24	3275	4701	5	5

Building Envelope Savings - Cooling Savings

BUILDING	TYPE	SUBTYPE	% of Building Cooled	INFILTRATION REDUCTION (CFM)	TOTAL HEAT CONSTANT	INTERIOR DRY BULB TEMP (F)	EXTERIOR DRY BULB TEMP (F)
Ramapo High School	Door Weather Stripping	Double Door - Sides, Sweep (UT)	64%	30	4.5	72.0	75.0
Ramapo High School	Door Weather Stripping	Double Door - Sides, Sweep, Center (UT)	64%	367	4.5	72.0	75.0
Ramapo High School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	64%	75	4.5	72.0	75.0
Ramapo High School	Door Weather Stripping	Double Door - Sweep, Center (UT)	64%	20	4.5	72.0	75.0
Ramapo High School	Door Weather Stripping	Install Door Jamb Spacer (UT)	64%	0	4.5	72.0	75.0
Ramapo High School	Door Weather Stripping	Single Door - Sides, Sweep (UT)	64%	385	4.5	72.0	75.0
Ramapo High School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	64%	121	4.5	72.0	75.0
Ramapo High School	Door Weather Stripping	Single Door - Sweep (UT)	64%	5	4.5	72.0	75.0
Ramapo High School	Overhand Air Sealing	Block, Seal (SF)	64%	16	4.5	72.0	75.0
Ramapo High School	Roof-Wall Intersection Air Sealing	Block, Seal (LF)	64%	518	4.5	72.0	75.0
Ramapo High School	Roof-Wall Intersection Air Sealing	Block, Seal Paint (LF)	64%	33	4.5	72.0	75.0
Ramapo High School	Roof-Wall Intersection Air Sealing	Seal (LF)	64%	815	4.5	72.0	75.0
Ramapo High School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	64%	16	4.5	72.0	75.0
Ramapo High School	Roof-Wall Intersection Air Sealing	Seal Paint (LF)	64%	36	4.5	72.0	75.0
Indian Hills High School	Buck Frame Air Sealing	Seal (LF)	40%	73	4.5	72.0	75.0
Indian Hills High School	Buck Frame Air Sealing	Seal Exposed (LF)	40%	65	4.5	72.0	75.0
Indian Hills High School	Caulking	Interior Seal Oversized (LF)	40%	6	4.5	72.0	75.0
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Center (UT)	40%	10	4.5	72.0	75.0
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Sweep (UT)	40%	65	4.5	72.0	75.0
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Sweep, Center (UT)	40%	301	4.5	72.0	75.0
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Top, Sweep (UT)	40%	24	4.5	72.0	75.0
Indian Hills High School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	40%	138	4.5	72.0	75.0
Indian Hills High School	Door Weather Stripping	Double Door - Sweep, Center (UT)	40%	24	4.5	72.0	75.0
Indian Hills High School	Door Weather Stripping	Single Door - Sides, Sweep (UT)	40%	63	4.5	72.0	75.0
Indian Hills High School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	40%	28	4.5	72.0	75.0
Indian Hills High School	Overhang Air Sealing	Seal (LF)	40%	12	4.5	72.0	75.0
Indian Hills High School	Roof-Wall Intersection Air Sealing	Block, Seal (LF)	40%	361	4.5	72.0	75.0
Indian Hills High School	Roof-Wall Intersection Air Sealing	Block, Seal Paint (LF)	40%	34	4.5	72.0	75.0
Indian Hills High School	Roof-Wall Intersection Air Sealing	Seal (LF)	40%	122	4.5	72.0	75.0
Indian Hills High School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	40%	47	4.5	72.0	75.0
Indian Hills High School	Roof-Wall Intersection Air Sealing	Seal Paint (LF)	40%	14	4.5	72.0	75.0
Indian Hills High School	Wall Air Sealing	Block, Seal (SF)	40%	175	4.5	72.0	75.0
Indian Hills High School	Wall Air Sealing	Block, Seal Exposed (UT)	40%	1	4.5	72.0	75.0

Building Envelope Savings - Cooling Savings											
BUILDING	INTERIOR DRY RELATIVE HUMIDITY (%)	EXTERIOR RELATIVE HUMIDITY (%)	INTERIOR ENTHALPY (SUMMER)	EXTERIOR ENTHALPY (SUMMER)	ENTHALPY	TONS	EFFICIENCY (kW/TON)	COOLING HOURS (HRS)	INFILTRATION ELECTRIC SAVINGS (kWh)	TOTAL COOLING SAVINGS (kWh)	TOTAL COOLING SAVINGS (kW)
Ramapo High School	40.0	75.0	24.55	33.27	8.72	0.10	1.40	668	92	92	0.14
Ramapo High School	40.0	75.0	24.55	33.27	8.72	1.20	1.40	668	1120	1,120	1.68
Ramapo High School	40.0	75.0	24.55	33.27	8.72	0.24	1.40	668	228	228	0.34
Ramapo High School	40.0	75.0	24.55	33.27	8.72	0.06	1.40	668	60	60	0.09
Ramapo High School	40.0	75.0	24.55	33.27	8.72	0.00	1.40	668	0	0	0.00
Ramapo High School	40.0	75.0	24.55	33.27	8.72	1.26	1.40	668	1175	1,175	1.76
Ramapo High School	40.0	75.0	24.55	33.27	8.72	0.39	1.40	668	369	369	0.55
Ramapo High School	40.0	75.0	24.55	33.27	8.72	0.01	1.40	668	14	14	0.02
Ramapo High School	40.0	75.0	24.55	33.27	8.72	0.05	1.40	668	49	49	0.07
Ramapo High School	40.0	75.0	24.55	33.27	8.72	1.69	1.40	668	1582	1,582	2.37
Ramapo High School	40.0	75.0	24.55	33.27	8.72	0.11	1.40	668	101	101	0.15
Ramapo High School	40.0	75.0	24.55	33.27	8.72	2.66	1.40	668	2489	2,489	3.73
Ramapo High School	40.0	75.0	24.55	33.27	8.72	0.05	1.40	668	50	50	0.07
Ramapo High School	40.0	75.0	24.55	33.27	8.72	0.12	1.40	668	110	110	0.16
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.24	1.38	668	221	221	0.33
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.21	1.38	668	197	197	0.30
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.02	1.38	668	18	18	0.03
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.03	1.38	668	29	29	0.04
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.21	1.38	668	197	197	0.29
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.98	1.38	668	910	910	1.36
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.08	1.38	668	73	73	0.11
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.45	1.38	668	417	417	0.62
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.08	1.38	668	73	73	0.11
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.21	1.38	668	191	191	0.29
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.09	1.38	668	84	84	0.13
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.04	1.38	668	37	37	0.06
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	1.18	1.38	668	1093	1,093	1.64
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.11	1.38	668	102	102	0.15
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.40	1.38	668	370	370	0.55
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.15	1.38	668	141	141	0.21
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.05	1.38	668	42	42	0.06
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.57	1.38	668	528	528	0.79
Indian Hills High School	40.0	75.0	24.55	33.27	8.72	0.00	1.38	668	4	4	0.01

Enthalpy

Based on Interior Relative Humidity of 40% and temperature of 72 degrees F = 24.55 btu/lb. Exterior Enthalpy based on outside relative humidity estimate of 75% and the below NOAA summer temperature data.

Heat Efficiency Factor

The derivation of the Efficiency Factor is based on sensible heat constant (1.08 * 24 Hours per Day) and an assumed efficiency percentage for the heating plant in the building. The efficiency of the heating plant is captured as a percentage of the total energy output of the heating system.

Calculation is = 1.08 * 24 hours per day = 25.92; in order to get the Efficiency Factor in the denominator and account for system efficiency = 1/ (25.92 / (1,000,000 Btus * **Heating** Plant Efficiency Percent).

Infiltration Heating Savings (therm) = Infiltration Reduction (CFM) * Heating Degree Days (HDD) / Heat Efficiency Factor

Thermal Insulation Savings (therm) = Existing Heat Loss (therm) - Proposed Heat Loss (therm)

Existing Heat Loss (therm) = (Existing U-Value * (Hours/Day * Heating Degree Days (HDD)) * Surface Area (Sqft)) / Heating Efficiency (%) / 100,000 Btu/Therm

Proposed Heat Loss (therm) = (Proposed U-Value * (Hours/Day * Heating Degree Days (HDD)) * Surface Area (Sqft)) / Heating Efficiency (%) / 100,000 Btu/Therm

Infiltration Cooling Savings (kWh) = Tons * Efficiency (kW/ton) *Cooling Degree Days (CDD)*12000 btu/hr *0.000293071

Tons = Inflitration Reduction (CFM) * Total Heat Constant * Enthalpy / 12,0000 Btu/hr

Insulation Savings (kWh) = Existing Cooling Loss (kWh) - Proposed Cooling Loss (kWh)

Existing Cooling Loss (kWh) = (Existing U-Value) * (Hours/Day) * (Cooling Degree Days (CDD)) * (Surface Area (Sqft)) * (Cooling Efficiency (kWh/ton-hr)) * (1 Ton-hr/12,000 Btu)

Proposed Cooling Loss (kWh) = (Proposed U-Value) * (Hours/Day) * (Cooling Degree Days (CDD)) * (Surface Area (Sqft)) * (Cooling Efficiency (kWh/ton-hr)) * (1 Ton-hr/12,000 Btu)

ECM 10 – Freezer Thermostat Control

RAMAPO INDIAN HILLS RHSD

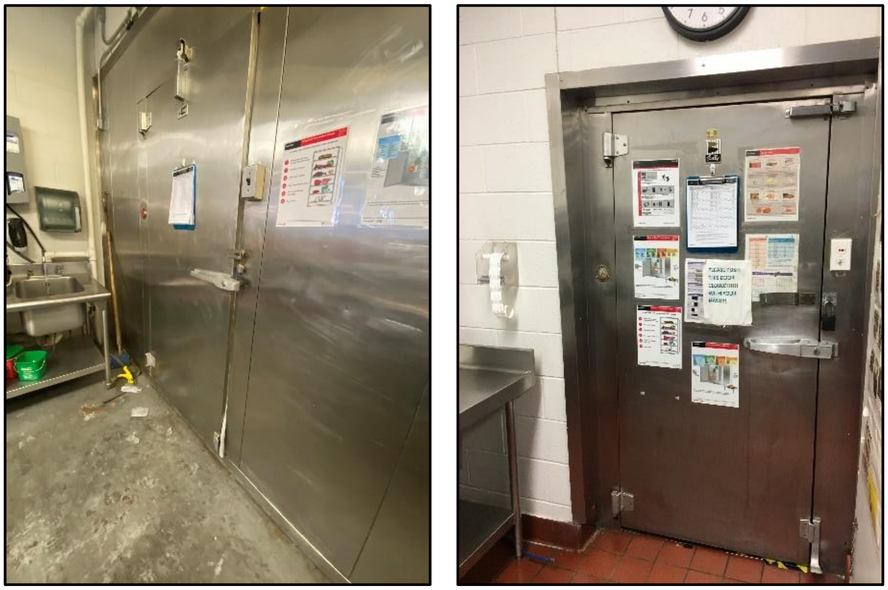
✓	ECM evaluated but not included
✓ (green)	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
10	Freezer Thermostat Control	✓	✓

Commercial refrigerators waste 20% of their energy and run 50% or more cycles than necessary trying to keep temperature constant. This is because air temperature is measured instead of food temperature. eTemp is an energy saving device for commercial refrigerators (walk-in and reach-in coolers and freezers). It is a product temperature sensor that upgrades your existing cooler's air-temp thermostats into product-temp thermostats. Since a food product's temperature change is more gradual than the surrounding air temperature, conventional refrigeration units that control to maintain an air temperature at set point can waste energy and run more cycles than necessary by causing the compressor to overreact to air temperature changes. This product mimics actual food temp so the current thermostat is monitoring related food temperature rather than the surrounding air temperature.

This product covers a wide band of thermal properties, as specified by the National Sanitation Foundation, so no food and beverage products are excluded from the applicable lists of products that can use this device. In addition, NSF performed its own separate analysis which resulted in eTemp being Certified by the NSF for food safety as per their protocols.

Existing Conditions



Existing Freezers at Ramapo HS and Indian Hills HS

Scope of Work

eTemp devices will be installed on the following Walk-In Freezers and Coolers, and Reach-In Coolers between both schools:

eTemp		
BUILDING NAME	**Unit Type**	**Quantity**
Ramapo High School	**Walk-In Freezer**	1
Ramapo High School	**Walk-In Cooler**	2
Ramapo High School	**Reach-In Cooler**	9
Indian Hills High School	**Walk-In Freezer**	1
Indian Hills High School	**Walk-In Cooler**	2
Indian Hills High School	**Reach-In Cooler**	4

ECM Calculations

Energy Savings from the installation of eTemp is shown below

CALCULATED SAVINGS									
eTemp - Energy Savings									
BUILDING NAME	Unit Type	Quantity	Compressor (kW)	Existing Runtime %	Existing Energy Use (kWh/unit)	Runtime % w/ eTemp	Proposed Energy Use (kWh/unit)	Total Demand Savings (kW)	Total Energy Savings (kWh)
Ramapo High School	Walk-In Freezer	1	5.28	40%	18,484	32%	14,787	0	3,697
Ramapo High School	Walk-In Cooler	2	2.93	40%	10,267	32%	8,213	0	4,107
Ramapo High School	Reach-In Cooler	9	1.76	40%	6,160	32%	4,928	0	11,088
Indian Hills High School	Walk-In Freezer	1	5.28	40%	18,484	32%	14,787	0	3,697
Indian Hills High School	Walk-In Cooler	2	2.93	40%	10,267	32%	8,213	0	4,107
Indian Hills High School	Reach-In Cooler	4	1.76	40%	6,160	32%	4,928	0	4,928

ECM 11 – Water Conservation

RAMAPO INDIAN HILLS RHSD

✔	ECM evaluated but not included
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
11	Water Conservation	✔	✔

It takes a considerable amount of energy to deliver and treat the water you use every day. For example, letting your faucet run for five minutes uses about as much energy as letting a 60-watt light bulb run for 22 hours. Pump and water heating energy is required to deliver hot water to the end user. Installing new fixtures and aerators can conserve substantial energy while reducing water consumption as well.
New low flow fixtures are rated at 1.5 gallons per minute and can be fitted with time based automatic shutoffs.

Fixture with aerator

Existing Conditions

Existing Urinals consist of models with an average flow of 1.3 GPM. These diaphragms and components deteriorate over time due to the flexing of the rubber and chloramines in the water treatment process. Urinal valves over 5 years in age have partially degraded diaphragms creating an average of 10% to 15% additional water per flush for those fixtures. The fixtures should be retrofit to low flow using newer chloramine resistant synthetic diaphragm valves and all fixtures should be change to ultra-low flow standards. Existing faucets evaluated for water conservation measures consist of models with an average flow of 2.2 GPM.

Existing equipment at Ramapo HS and Indian Hills HS

Scope of Work

190 existing faucets within the facilities will retrofit with high efficiency .5 GPM Neoperl aerators. 51 existing urinals will be retrofit with .5 GPF (gallons per flush) urinal flush valves. 1 kitchen faucet will be retrofit with a 1.5 GPM Neoperl aerator.

Water Conervation Scope of Work		
BUILDING	**CATEGORY**	**QUANTITY**
Ramapo High School	Urinal Flush Valves	38
	Faucets - Aerators	112
Indian Hills High School	Urinal Flush Valves	13
	Faucets - Aerators	79

		Total	Ramapo High School	Indian Hills High School
URINAL FLUSHVALVES			0	0
Urinal Flush Valve	Sloan GEM 180-0.5	**51**	38	13
Aerators			0	0
Vandal Proof Aerator	Neoperl 40-114	**190**	111	79
Vandal Proof Kitchen Aerator	Neoperl 40-614	**1**	1	0
Sum of Plumbing Retrofit		**242**	**150**	**92**

ECM Calculations

Fuel savings associated with water conservation from faucet aerators is calculated using NJ BPU Protocols:

CALCULATED SAVINGS

Water Conservation Fuel Savings

BUILDING NAME	DHW Type	Days/Wk	Wk/Yr	Faucets Aerators: Number of Fixtures	Existing (GPM)	Proposed (GPM)	Duration (Min)	Days per year	dT (F)	EFF	Fuel Savings (Therms)
Ramapo High School	Natural Gas	5	38.0	112	2.2	1.5	20.0	190	27.40	80%	850
Indian Hills High School	Natural Gas	5	38.0	79	2.2	1.5	20.0	190	27.40	80%	600

Water Conservation Water Savings

BUILDING NAME	Population			Usage per Day				
	Students	Staff	Total	Urinal (flush)	Faucet (hr)	CF%	Urinal	Faucet
Ramapo High School	1,157	113	1269	1.0	0.33	50%	635	209
Indian Hills High School	827	72	899	1.0	0.33	50%	450	148

Water Conservation Water Savings

BUILDING NAME	Urinal Valve Replacement							
	Days Per Year	Fixture QTY	Avg Daily Usage	Existing Urinal Flow (GPM)	Pre Water Used Per Year (Gal)	Proposed Urinal Flow (GPM)	Proposed Water Used Per Year (Gal)	Water Saved Per Year (Gal)
Ramapo High School	190	38	16.7	1.3	156,722	0.5	60,278	96,444
Indian Hills High School	190	13	34.6	1.3	111,039	0.5	42,707	68,332

Water Conservation Water Savings

BUILDING NAME	Faucet Aerator Installation								Total Savings
	Days Per Year	Fixture QTY	Avg Daily Usage	Existing Faucet Flow (GPM)	Pre Water Used Per Year (Gal)	Proposed Faucet Flow (GPM)	Proposed Water Used Per Year (Gal)	Water Saved Per Year (Gal)	Total Water Savings (Gal)
Ramapo High School	190	112	1.9	2.2	87,523	1.5	59,675	27,848	124,292
Indian Hills High School	190	79	1.9	2.2	62,011	1.5	42,280	19,731	88,062

2021 NJ BPU Protocols:

Low Flow Faucet Aerators and Showerheads

Algorithm

Therm or kWh Fuel Savings/yr = N * M * D * (F_b – F_q) * (8.33 * DT / EFF)/ C

Definition of Variables

N = Number of fixtures

M = Minutes per day of device usage

D = Days per year of device usage

F_b = Baseline device flow rate (gal/m)

F_q = Low flow device flow rate (gal/m)

8.33 = Heat content of water (Btu/gal/°F)

DT = Difference in temperature (°F) between cold intake and output

EFF = Efficiency of water heating equipment

C = Conversion factor from Btu to therms or kWh = (100,000 for gas water heating (Therms), 3,413 for electric water heating (kWh)

Summary of Inputs

Low Flow Faucet Aerators and Showerheads

Component	Type	Value	Source
N	Variable		Application
M	Fixed	Aerators 30 minutes	1
		Shower heads 20 minutes	
D	Fixed	Aerators 260 days	1
		Shower heads 365 days	
F_b	Fixed	Aerators 2.2 gpm	
		Showerhead 2.5 gpm	
F_q	Fixed	Aerators <=1.5 gpm (kitchen) <=0.5 gpm (public restroom) <=1.5 gpm (private restroom)	2,3,4
		Showerheads <=2 gpm	4
DT	Fixed	Aerators 27.4°F	5
		Showerheads 44.4°F	6
EFF	Fixed	98% electric 80% natural gas	7,8

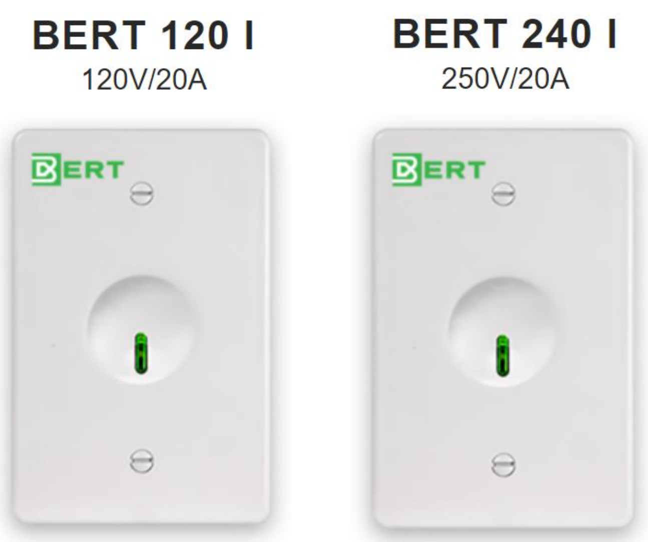
ECM 12 – Plug Load Controls

RAMAPO INDIAN HILLS RHSD

✓	ECM evaluated but not included
✓ (green)	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
12	Plug Load Controls	✓	✓

Plug loads are often used for a small portion of the day. Left unmanaged, these loads can add a significant usage and cost to a buildings electric load. Plug load controls utilize specialty sockets from BERT that have software to track real-time usage of your appliances. The software also allows the user to use a web browser to view this usage and automatically turn on/off all appliances plugged into these outlets.



Scope of Work

Existing wall plugs within the facilities will be retrofitted with specialty controllable wall plugs.

Plug Load Controller Estimate			
BUILDING	CATEGORY	NOTES	QUANTITY
Ramapo High School	Bert 110X	Network Verification Units	2
	Bert 110X		29
	Extended Maintenance	3 years extended software maintenance	29
	Bert Threshold Vend Software	Threshold/Vend Software Liscense Fee	1
	Extended Maint.	3 years extended software maintenance	1
	Bert 120I Inline		0
	Extended Maintenance	3 years extended software maintenance	0
	Bert 240I Inline		0
	Extended Maintenance	3 years extended software maintenance	0
	Device Sticker		29
	Instructions		29
	Bert Harness		1
	Install Bert Harness		1
	Set up	Preload SSID and Passphrase - plug in	29
	Set up	Preload SSID and Passphrase - inline	0
	Program	Name, Group and Schedule Berts	29
	Test	Verify Network Communication and Final Test	29
	Training	Remote Software Training/Customer Signoff	1
	Installation	Install Berts and record MAC Address - plug in units only	29
	Travel	Travel expenses	1
	Shipping charges	FedEx Ground	1
Indian Hills High School	Bert 110X	Network Verification Units	0
	Bert 110X		127
	Extended Maintenance	3 years extended software maintenance	127
	Bert Threshold Vend Software	Threshold/Vend Software Liscense Fee	69
	Extended Maint.	3 years extended software maintenance	69
	Bert 120I Inline		0
	Extended Maintenance	3 years extended software maintenance	0
	Bert 240I Inline		0
	Extended Maintenance	3 years extended software maintenance	0
	Device Sticker		127
	Instructions		127
	Bert Harness		2
	Install Bert Harness		2
	Set up	Preload SSID and Passphrase - plug in	127
	Set up	Preload SSID and Passphrase - inline	0
	Program	Name, Group and Schedule Berts	127
	Test	Verify Network Communication and Final Test	127
	Training	Remote Software Training/Customer Signoff	1
	Installation	Install Berts and record MAC Address - plug in units only. Assumes no prevailing wage	127
	Travel	Travel expenses	1
	Shipping charges	FedEx Ground	1

ECM Calculations

Energy savings are calculated by multiplying the equipment Standby Power Draw (W) by the number of hours the plug load will shut the equipment off completely:

CALCULATED SAVINGS

Plug Load Controller Savings

BUILDING NAME	Device Type	Plug Load Type	Quantity	Standby Power Draw (W)	Baseline Hours Scheduled ON per Year	Controller Hours Scheduled ON per Year	Controller Hours Scheduled OFF per Year	Annual Energy Savings (kWh)	Total Annual Energy Savings (kWh)
Ramapo High School	Projector	Bert 110X	0	8	8,760	2,600	6,160	0	5,975
Ramapo High School	Smartboard TV	Bert 110X	1	8	8,760	2,600	6,160	49	
Ramapo High School	Projector/Smartboard	Bert 110X	0	10	8,760	2,600	6,160	0	
Ramapo High School	Amp	Bert 110X	0	6	8,760	2,600	6,160	0	
Ramapo High School	Charging Cart	Bert 110X	1	37	8,760	2,600	6,160	228	
Ramapo High School	Printer	Bert 110X	12	15	8,760	2,600	6,160	1,109	
Ramapo High School	Large Copy Machine	Bert 110X	9	40	8,760	2,600	6,160	2,218	
Ramapo High School	TV	Bert 110X	0	6	8,760	2,600	6,160	0	
Ramapo High School	Snack Vending	Bert 110X	0	40	8,760	2,600	6,160	0	
Ramapo High School	Soda Vending	Bert 110X	1	320	8,760	2,600	6,160	1,971	
Ramapo High School	Large Coffee	Bert 110X	0	56	8,760	2,600	6,160	0	
Ramapo High School	H/C Water Disp.	Bert 110X	1	61	8,760	2,600	6,160	376	
Ramapo High School	Other	Bert 110X	4	1	8,760	2,600	6,160	25	
Ramapo High School	AC - 110V (20A)	Bert 240I Inline	0	8	8,760	2,600	6,160	0	
Ramapo High School	AC - 220V (< 20A)	Bert 120I Inline	0	8	8,760	2,600	6,160	0	
Ramapo High School	Elec. Water Heater	Bert 240I Inline	0	80	8,760	2,600	6,160	0	
Ramapo High School	Exhaust Fan - 110V	Bert 110X	0	100	8,760	2,600	6,160	0	
Ramapo High School	Exhaust Fan - 220V	Bert 240I Inline	0	100	8,760	2,600	6,160	0	
Indian Hills High School	Projector	Bert 110X	69	8	8,760	2,600	6,160	3,400	16,213
Indian Hills High School	Smartboard TV	Bert 110X	0	8	8,760	2,600	6,160	0	
Indian Hills High School	Projector/Smartboard	Bert 110X	0	10	8,760	2,600	6,160	0	
Indian Hills High School	Amp	Bert 110X	0	6	8,760	2,600	6,160	0	
Indian Hills High School	Charging Cart	Bert 110X	2	37	8,760	2,600	6,160	456	
Indian Hills High School	Printer	Bert 110X	32	15	8,760	2,600	6,160	2,957	
Indian Hills High School	Large Copy Machine	Bert 110X	15	40	8,760	2,600	6,160	3,696	
Indian Hills High School	TV	Bert 110X	0	6	8,760	2,600	6,160	0	
Indian Hills High School	Snack Vending	Bert 110X	1	40	8,760	2,600	6,160	246	
Indian Hills High School	Soda Vending	Bert 110X	2	320	8,760	2,600	6,160	3,942	
Indian Hills High School	Large Coffee	Bert 110X	0	56	8,760	2,600	6,160	0	
Indian Hills High School	H/C Water Disp.	Bert 110X	4	61	8,760	2,600	6,160	1,503	
Indian Hills High School	Other	Bert 110X	2	1	8,760	2,600	6,160	12	
Indian Hills High School	AC - 110V (20A)	Bert 240I Inline	0	8	8,760	2,600	6,160	0	
Indian Hills High School	AC - 220V (< 20A)	Bert 120I Inline	0	8	8,760	2,600	6,160	0	
Indian Hills High School	Elec. Water Heater	Bert 240I Inline	0	80	8,760	2,600	6,160	0	
Indian Hills High School	Exhaust Fan - 110V	Bert 110X	0	100	8,760	2,600	6,160	0	
Indian Hills High School	Exhaust Fan - 220V	Bert 240I Inline	0	100	8,760	2,600	6,160	0	

4.6.3.11 Plug and Process Load Reduction Measures

- EEMs saving energy by eliminating or reducing idle or stand-by power consumption of connected plug loads through the use of the following eligible plug load controls. The percentages presented in the following tables represent the maximum energy reduction percentage that can be claimed for the plug load control.

  - *Load Sensing Controls:* Monitors a specific devices power state and de-energizes connected auxiliary units when the monitored devise enters a low power state.

Load Sensing Control	
Space Type	**Percent Energy Reduction from Baseline**
Workstation	4%
Print Rooms	32%

  - *Occupancy Sensing Controls:* Automatically de-energize devices when no user is present for a set period of time.

Occupancy Control	
Space Type	**Percent Energy Reduction from Baseline**
All	21%

  - *Scheduled Timer Control:* Allows users to set a schedule to energize and de-energize devices based on the devices usage pattern and space schedule.

Schedule Timer Control	
Space Type	**Percent Energy Reduction from Baseline**
Workstation	26%
Print Rooms	50%
Break Rooms	46%

ECM 13 – Retro-commissioning

RAMAPO INDIAN HILLS RHSD

✓	ECM evaluated but not included
✓	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
13	Retro-Commissioning	✓	✓

Background/Scope of Work

Due to the complexity of today's HVAC systems and controls, it is likely for systems to be operating incorrectly or not as efficiently as they could be. Retro-commissioning studies reveal hidden deficiencies and highlights operational & maintenance (O&M) issues that could have been avoided as well as exposes hidden control system problems. There are valuable benefits to retro-commissioning in existing buildings. It is a detailed and specialized process that reviews how an HVAC system is controlled and designed to operate. Applying retro-commissioning to existing facilities includes planning, discovering root causes of inefficiencies, development of a cost-effective project delivery and a focus on optimizing value to the building owner. The study includes functional system testing under various modes, such as heating or cooling loads, occupied and unoccupied modes, varying outside air temperature and space temperatures.

This is a systematic process to ensure that the building energy systems perform interactively according to the original design intent and the current operational needs of the facility. Retro-commissioning is a common practice recommended by the American Society of Heating Refrigeration and Energy (ASHRAE) to be revisited every couple of years. We recommend that an engineering firm who specializes in energy control systems and retro-commissioning be contacted for a detailed evaluation and implementation costs. Facility operations personnel would work with the engineers to develop goals and objectives. During on-site testing, the qualified personnel conducting the study would immediately make any no/low cost improvements as identified. Furthermore, any suggested corrective actions which require the purchase of material, a contractor who specializes in that scope of work would be contacted to implement the remaining improvements. DCO Energy is budgeting $218,000 for on-site testing, a retro-commissioning report, and contracting to resolve district building system issues.

Energy Savings Calculations

According to a Lawrence Berkeley National Laboratory study, *The Cost-Effectiveness of Commercial Buildings Commissioning*, “For existing buildings, we found median commissioning costs of $0.27/ft2, whole-building energy savings of 15 percent, and payback times of 0.7 years.” Savings are conservatively estimated to be 3.75% of existing site electric and 5% of the existing natural gas use:

Retro-Commissioning Savings						
BUILDING	EXISTING SITE kWh	% ELECTRIC SAVINGS	kWh SAVINGS	EXISTING SITE THERMS	% THERM SAVINGS	THERMS SAVINGS
Ramapo High School	1,611,211	3.75%	60,420	89,760	5%	4,488
Indian Hills High School	1,518,622	3.75%	56,948	98,373	5%	4,919

ECM 14 – Solar PPA

RAMAPO INDIAN HILLS RHSD

✓ (white)	ECM evaluated but not included
✓ (green)	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
14	Solar PPA	✓	✓

The renewable energy industry is one of the fastest growing and evolving components to modern building system design. The ability to capture solar energy will provide long term economic and environmental benefits. Technology improvements are rapidly evolving as well, and the market is flooded with new products with new features that have only been available within the last few years, with promising new technologies and updates on the verge of becoming available to the market.

Photovoltaic (PV) solar array

Clients have the opportunity to purchase power through a Power Purchase Agreement, predetermining fixed low rates for the duration of the agreement, without having to manage any part of the process. This allows the solar provider to manage compliance reporting, filings, and maintenance of the equipment for the entire length of the contract.

A solar PPA makes going green easy. Work takes place around the client’s schedule, and a safe and functional environment is maintained throughout installation of the system.

Assessment
A preliminary assessment of your facilities will allow for the design of a system that meets your energy needs and environmental goals
Agreement
Power Purchase Agreements allow for the sale of the energy produced on a per kWh basis, while a lease agreement allows the solar provider to access the system, they own so that they may monitor and maintain the system for you.

Installation
A turnkey system includes the design, construction, commissioning, and interconnection with local utilities.

Monitoring
The solar provider monitors the PV installation to ensure performance and for ease of billing. The client has the capability to track output and environmental benefits online.

Management
The solar provider handles all compliance and reporting requirements for the client. They will file documentation with federal and state agencies and participate in state and utility REC markets.

Scope of Work

- Savings estimates are calculated from proposals received during the Ramapo Indian Hills Regional High School District Solar PPA RFP process
- Installation of the Solar PV System shall be in accordance with NFPA 70. NEC 2011. ARTICLE 690.Solar Photovoltaic (PV) Systems
- PPA Firm will receive any incentives available

Solar Photovoltaic Arrays

Ramapo Indian Hills Regional High School District roof mounted solar opportunities are show below:

Ramapo High School

Indian Hills High School

ECM Calculations

The energy savings shown below are a result of the reduced electrical cost from the PPA for the kWh generated by the solar panels. Actual rates and solar generation estimates were taken from the proposals received during the Ramapo Indian Hills Regional High School District Solar PPA RFP process. A comparison was done to ensure the generated kWh did not exceed the post-project estimated energy consumption. In cases where the generated kWh exceeded the post-project electrical consumption, the generation numbers were reduced to ensure the site would not generate more electric than it consumes. The PPA term is 15 years.

INSTALLED CAPACITY (kWdc)	TOTAL ECM YEAR 1 SAVINGS	PPA RATE ($/kWh)	ANNUAL ESCALATION RATE	ANNUAL PANEL DERATING
2,372	$169,475	$0.0449	1.25%	1.00%

Solar PPA - Rates & Savings

BUILDING	MOUNTING CATEGORY	INSTALLED ARRAY (kW)	EFLH	INSTALLED kWh GENERATION	$$/kWh RATES		SAVINGS	TOTAL SAVINGS
					UTILITY	SOLAR PPA		
Ramapo High School	Roof	1,231.8	1,190	1,466,106	$0.105	$0.0449	$87,543	**$87,543**
Indian Hills High School	Roof	1,140.0	1,204	1,372,130	$0.105	$0.0449	$81,932	**$81,932**

YEAR	PPA kWh PRODUCTION	UTILITY SAVINGS	PPA COST	NET SOLAR SAVINGS
1	2,838,236	$296,912	($127,437)	$169,475
2	2,809,854	$300,409	($127,739)	$172,670
3	2,781,755	$303,948	($128,043)	$175,905
4	2,753,938	$307,529	($128,347)	$179,182
5	2,726,398	$311,151	($128,652)	$182,500
6	2,699,134	$314,817	($128,957)	$185,859
7	2,672,143	$318,525	($129,264)	$189,262
8	2,645,422	$322,277	($129,571)	$192,707
9	2,618,967	$326,074	($129,878)	$196,196
10	2,592,778	$329,915	($130,187)	$199,728
11	2,566,850	$333,801	($130,496)	$203,305
12	2,541,181	$337,734	($130,806)	$206,928
13	2,515,770	$341,712	($131,117)	$210,596
14	2,490,612	$345,737	($131,428)	$214,310
15	2,465,706	$349,810	($131,740)	$218,070
Total	**39,718,743**	**$4,840,352**	**($1,943,661)**	**$2,896,691**

Ramapo High School						
YEAR	$$/kWh RATES		SOLAR kWh	UTILITY SAVINGS	PPA COST	SAVINGS
	UTILITY	SOLAR PPA				
1	$0.105	$0.0449	1,466,106	$153,371	($65,828)	$87,543
2	$0.107	$0.0455	1,451,445	$155,178	($65,985)	$89,194
3	$0.109	$0.0460	1,436,931	$157,006	($66,141)	$90,865
4	$0.112	$0.0466	1,422,561	$158,856	($66,298)	$92,557
5	$0.114	$0.0472	1,408,336	$160,727	($66,456)	$94,271
6	$0.117	$0.0478	1,394,252	$162,620	($66,614)	$96,007
7	$0.119	$0.0484	1,380,310	$164,536	($66,772)	$97,764
8	$0.122	$0.0490	1,366,507	$166,474	($66,930)	$99,544
9	$0.125	$0.0496	1,352,842	$168,435	($67,089)	$101,346
10	$0.127	$0.0502	1,339,313	$170,419	($67,249)	$103,171
11	$0.130	$0.0508	1,325,920	$172,427	($67,408)	$105,019
12	$0.133	$0.0515	1,312,661	$174,458	($67,568)	$106,890
13	$0.136	$0.0521	1,299,534	$176,513	($67,729)	$108,784
14	$0.139	$0.0528	1,286,539	$178,593	($67,890)	$110,703
15	$0.142	$0.0534	1,273,674	$180,696	($68,051)	$112,645
Total			**20,516,932**	**$2,500,310**	**($1,004,009)**	**$1,496,302**

Indian Hills High School						
YEAR	$$/kWh RATES		SOLAR kWh	UTILITY SAVINGS	PPA COST	SAVINGS
	UTILITY	SOLAR PPA				
1	$0.105	$0.0449	1,372,130	$143,540	($61,609)	$81,932
2	$0.107	$0.0455	1,358,409	$145,231	($61,755)	$83,476
3	$0.109	$0.0460	1,344,824	$146,942	($61,902)	$85,040
4	$0.112	$0.0466	1,331,376	$148,673	($62,049)	$86,624
5	$0.114	$0.0472	1,318,062	$150,424	($62,196)	$88,228
6	$0.117	$0.0478	1,304,882	$152,196	($62,344)	$89,853
7	$0.119	$0.0484	1,291,833	$153,989	($62,492)	$91,498
8	$0.122	$0.0490	1,278,915	$155,803	($62,640)	$93,163
9	$0.125	$0.0496	1,266,126	$157,639	($62,789)	$94,850
10	$0.127	$0.0502	1,253,464	$159,496	($62,938)	$96,558
11	$0.130	$0.0508	1,240,930	$161,374	($63,088)	$98,287
12	$0.133	$0.0515	1,228,520	$163,275	($63,237)	$100,038
13	$0.136	$0.0521	1,216,235	$165,199	($63,388)	$101,811
14	$0.139	$0.0528	1,204,073	$167,145	($63,538)	$103,607
15	$0.142	$0.0534	1,192,032	$169,114	($63,689)	$105,425
Total			**19,201,811**	**$2,340,042**	**($939,652)**	**$1,400,390**

ECM 16 – Roofing Upgrades

RAMAPO INDIAN HILLS RHSD

✔	ECM evaluated but not included
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
16	Roofing Upgrades	✔	✔

Single Ply Membrane Roof Restoration

Year after year, reflective elastomeric coatings continue to be used as a viable option for many roofing substrates, and single-ply membranes are no different. This system addresses all seams and penetrations that could potentially be a leak point while protective elastomeric coating maintains and restores the membrane. Single ply membrane restorations include the following benefits:

Performance

<u>Watertight</u>	Addresses all sources of roof leaks by sealing all seams and fasteners.
<u>Durable</u>	Resistant to damage from roof traffic and storm damage.
<u>UV Resistant</u>	Designed for the harshest UV conditions.
<u>Light Weight</u>	Very low impact on your overall roof weight-load.
<u>High Reflectivity</u>	Nearly 85% of all UV light is reflected and the High Emissivity gives the coating and Emissivity the ability to release any heat that is absorbed which keeps the roof surface +/- 10 degrees from ambient temperature.
<u>Disruption Free</u>	Installation is completed without bothering building occupants.

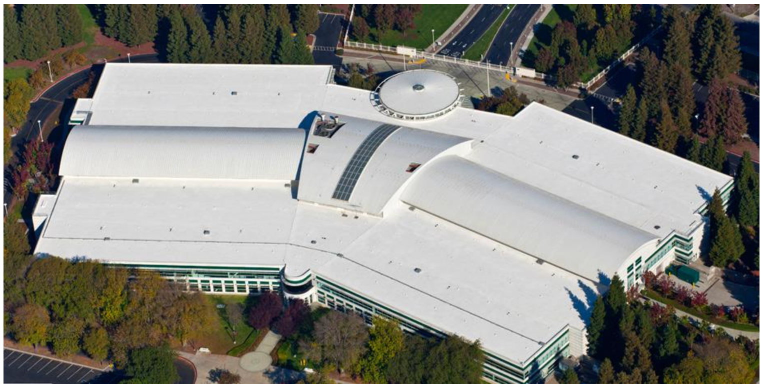
Extends Building Life	Cool roof surface will reduce expansion and contraction stresses on the building.

Value

Energy Savings	Reduced solar heat gain will cut summer energy costs by up to 30%.
No Tear Off	Typically no costly tear off required.
Low Cost	Keeps more money in your pocket compared to replacement systems.
Low Life Cycle Cost	With no tear-off and by simply maintaining the protective surface coating on your roof every 10-15 years, your roof can last indefinitely.
Rebates	Many local and federal rebates are available.
Tax Benefits	Can often be fully expensed in the year of installation.

Environment

No Tear Off	Typically no need to remove roof and fill our land-fills with roof waste.
Water-based	Non-hazardous, non-flammable and easy cleanup.
Low VOC	Meets the most stringent VOC requirements in the U.S.
Low Odor	Can be installed in situations where rooftop air handlers cannot be turned off.
Sustainable	Simply maintaining the protective surface coating on your roof every 10-15 years, your roof will last indefinitely.



Sample Installation Process (EPDM/BUR style roof restoration)

- Identify the coating system to be used. Adhesion test most likely necessary.
- Identify wet insulation to be replaced using infrared scans.
- Address all deficient seams and penetrations. Repair with "like" materials. Probe and inspect all seams.
- Power wash the roof to wash away all contaminants including dirt and loose particulates.
- Apply wash primer. Allow to sit for 10 minutes and begin washing off with high pressure power wash. (Only prime what you plan to coat that day)
- Apply thick bead of sealant to seam and feather out with a chip brush to a width of 3".
- Apply desired basecoat.
- Apply desired topcoat.

Sample Installation Process (Metal roof coating)

- Identify the coating system to be used. Adhesion test most likely necessary.
- Address all deficient seams and penetrations. Repair with "like" materials. Probe and inspect all seams.
- Power wash the roof to wash away all contaminants including dirt and loose particulates.
- Apply metal wash primer. Allow to sit for 10 minutes and begin washing off with high pressure power wash. (Only prime what you plan to coat that day)
- Apply thick bead of sealant to seam and feather out with a chip brush to a width of 3".
- Apply desired basecoat.
- Apply desired topcoat.

Spray Polyurethane Foam Roof Restoration

Spray polyurethane foam (commonly referred to as SPF) is a spray-applied rigid, insulating cellular plastic that is applied as a liquid, immediately expanding to 30 times its original volume. The resulting high density roofing foam is resistant to foot traffic and water. Spray polyurethane foam is the fastest growing insulating product in the world. As a roofing material it provides many benefits over traditional roofing materials. Exceptional durability, unmatched R-value, air barrier properties and a multitude

Spray polyurethane foam Roof Restoration of additional benefits make it a truly versatile roofing system. Spray Foam Roofing System is suitable for both new roofing and reroof applications.

Performance

Watertight: Because our systems are manufactured in place, major weaknesses, including seams and mechanical fasteners, are eliminated.
Durable: Resistant to damage from pedestrian traffic and storm damage.
UV Resistant: Unlike traditional roofing systems, this system has a surface designed for even the harshest UV conditions.
Seamless: Because our systems are manufactured in place, seams, the major weakness of most membrane systems, are eliminated.
Light Weight: Very low impact on the overall roof weight load.
Fully Adhered: Contributes to excellent wind uplift performance.
Breathable: Trapped moisture in the existing roof system will pass through the membrane.
Highly Heat Reflective: Dramatically improves occupants' comfort by typically cutting a summer roof surface temperature by 50-90˚
Reduces Movement: Insulation and reflective properties significantly reduce building stresses due to thermal expansion and contraction.
Disruption Free: Installation is completed without bothering building occupants.
Extends Building Life: Cool roof surface will reduce expansion and contraction stresses on the building.

Value

Very High R-value: R value of over 6.0 per inch. Effective insulation at high and low temperatures.
Energy Savings: SPF insulates, blocks radiant heat while topcoat is highly reflective.
No Tear Off: For reroofing applications, typically no costly tear off required.
No Fasteners or Seams: No problems with fastener shorts and gaps in insulation, leaking energy.
Air Barrier: Many membrane roofs act as bellows by actually pumping out conditioned air and bring in outside air.

Low Life Cycle Cost: Simply maintaining the protective surface coating on the roof every 10-15 years, your roof will last indefinitely.

Environment

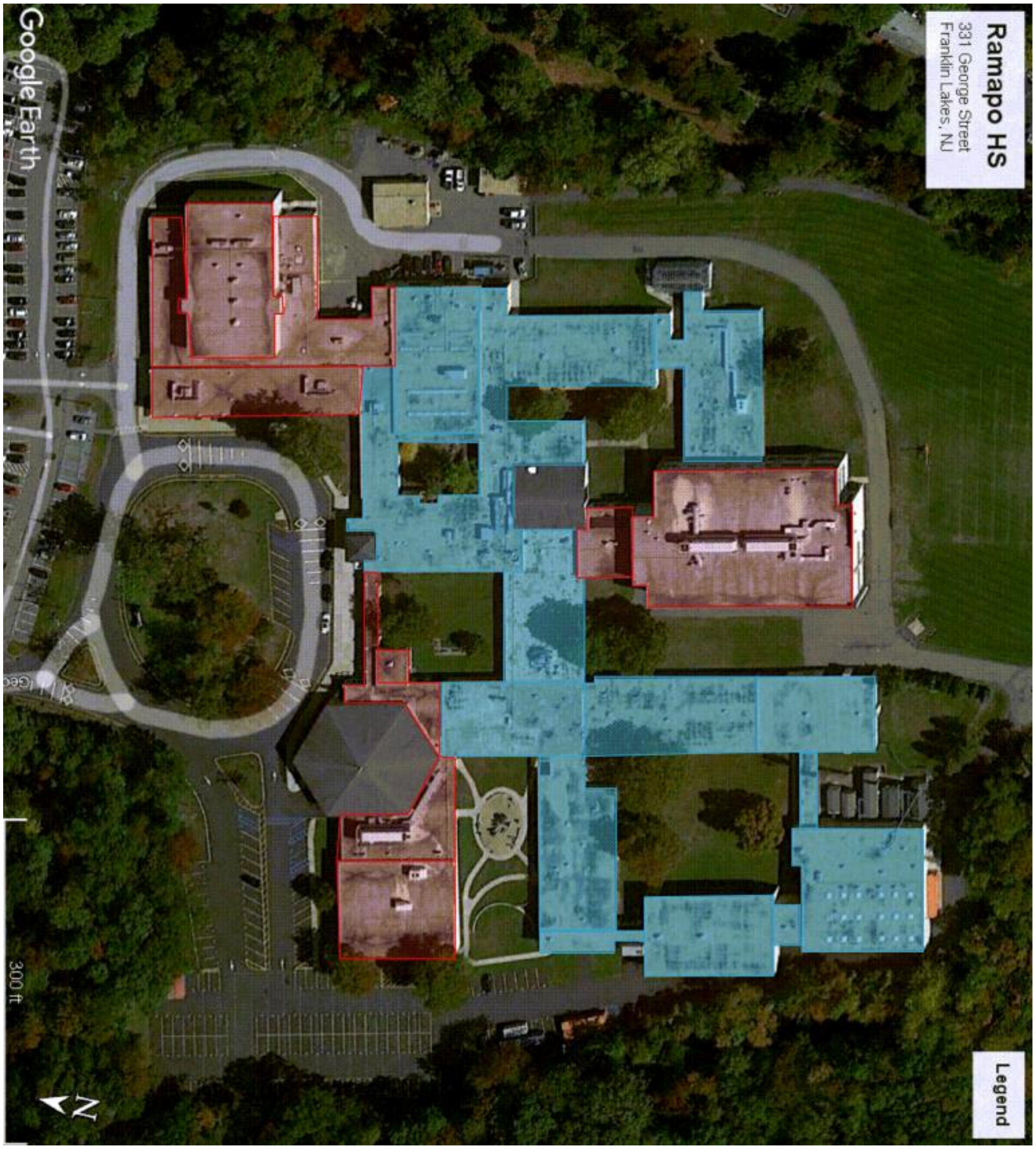
No Tear Off: Typically, no need to remove roof and fill our landfills with roof waste.
Environmentally Friendly: Non -hazardous, non- flammable and easy cleanup.
Low VOC: Meets the most stringent VOC requirements in the U.S.
Low Odor: Can be installed in situations where rooftop air handlers cannot be turned off.
Sustainable: Simply maintaining the protective surface coating on your roof every 10-15 years, the roof will last indefinitely.

Scope of Work

Roof sections and areas were identified by a roofing subcontractor to coincide with the installation of solar PV and are shown in red on the aerial photos below. The current scope of work has solar and roof upgrades for the following schools:

Roof Refurbishment - Solar PPA Scope of Work			
BUILDING	LOCATION	TYPE	QUANTITY (SF)
Ramapo High School	95% of ESIP (BASE)	Estimate Base on Solar Array - Coating	152,947
Indian Hills High School	95% of ESIP (BASE)	Estimate Base on Solar Array - Coating	111,343

Ramapo High School



Indian Hills High School

ECM Calculations

Energy Savings from the upgrades to district roofs are calculated below:

CALCULATED SAVINGS								
Roof Refurbishment - Heating Savings								
BUILDING	**ROOF SQFT**	**HEATING EFFICIENCY (%)**	**HOURS (HR/DAY)**	**HEATING DEGREE DAYS (°F-days)**	**EXISTING R-VALUE (ft2-°F-h/BTU)**	**EXISTING U-VALUE (BTU/ft2-°F-h)**	**PROPOSED R-VALUE (ft2-°F-h/BTU)**	**PROPOSED U-VALUE (BTU/ft2-°F-h)**
Ramapo High School	152,947	87.0%	24.00	4615	22	0.0455	24	0.042
Indian Hills High School	111,343	84.9%	24.00	4615	22	0.0455	24	0.042

Roof Refurbishment - Heating Savings				
BUILDING	**ROOF SQFT**	**EXISTING HEAT LOSS (THERM)**	**POST-RETRO FIT HEAT LOSS (THERM)**	**ROOF SAVINGS (THERM)**
Ramapo High School	152,947	8851	8113	738
Indian Hills High School	111,343	6603	6052	550

Roof Savings (therm) = Existing Heat Loss (therm) - Proposed Heat Loss (therm)

Existing Heat Loss (therm) = (Existing U-Value * (Hours/Day * Heating Degree Days (HDD)) * Surface Area (Sqft)) / Heating Efficiency (%) / 100,000 Btu/Therm

Proposed Heat Loss (therm) = (Proposed U-Value * (Hours/Day * Heating Degree Days (HDD)) * Surface Area (Sqft)) / Heating Efficiency (%) / 100,000 Btu/Therm

Roof Refurbishment- Cooling Savings								
BUILDING	ROOF SQFT	EFFICIENCY (kWh/ton-hr)	HOURS (HR/DAY)	COOLING HOURS (CDD)	EXISTING R-VALUE (ft2-°F-h/BTU)	EXISTING U-VALUE (BTU/ft2-°F-h)	PROPOSED R-VALUE (ft2-°F-h/BTU)	PROPOSED U-VALUE (BTU/ft2-°F-h)
Ramapo High School	152,947	1.40	24.00	954	22	0.0455	24	0.042
Indian Hills High School	111,343	1.38	24.00	954	22	0.0455	24	0.042

Roof Refurbishment- Cooling Savings				
BUILDING	ROOF SQFT	PRE-RETRO FIT COOLING LOSS (kWh)	POST-RETRO FIT COOLING LOSS (kWh)	ROOF SAVINGS (kWh)
Ramapo High School	152,947	18550	17004	1,546
Indian Hills High School	111,343	13365	12251	1,114

Roof Savings (kWh) = Existing Cooling Loss (kWh) - Proposed Cooling Loss (kWh)

Existing Cooling Loss (kWh) = (Existing U-Value) * (Hours/Day) * (Cooling Degree Days (CDD)) * (Surface Area (Sqft)) * (Cooling Efficiency (kWh/ton-hr)) * (1 Ton-hr/12,000 Btu)

Proposed Cooling Loss (kWh) = (Proposed U-Value) * (Hours/Day) * (Cooling Degree Days (CDD)) * (Surface Area (Sqft)) * (Cooling Efficiency (kWh/ton-hr)) * (1 Ton-hr/12,000 Btu)

ECMs Evaluated but Not Included

The energy conservation measures highlighted in this section were each evaluated during the investment grade audit. Due to high capital costs compared to annual energy savings and district priorities, these measures have not been included in the Energy Savings Plan.

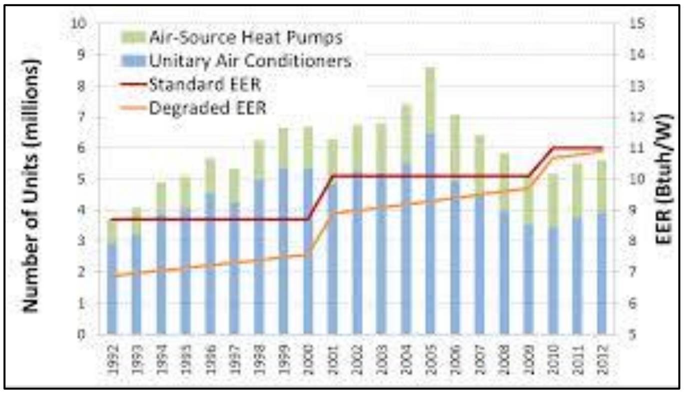
ECM 6 – Rooftop Unit Replacement

RAMAPO INDIAN HILLS RHSD

✓	ECM evaluated but not included
✓	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
6	Rooftop Unit Replacement	✓	✓

Many commercial buildings are operating with older and inefficient HVAC systems. The average life expectancy of commercial HVAC RTU equipment is 10 to 15 years—which means that many commercial buildings are ready for new natural gas rooftop units. Technology improvements and demand have led to greater energy efficiency and more choices in systems. Installing new, higher efficiency units will provide energy savings as well as deliver enhanced technology and controls of the RTUs when compared to the existing units.

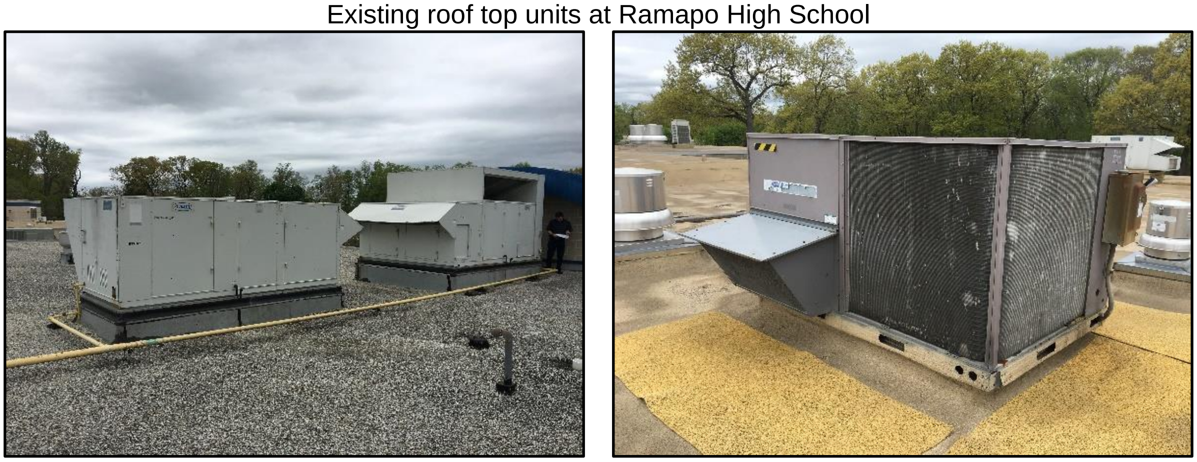


Existing Conditions

Ramapo High School – 21 total rooftop units currently serve this high school. Four (4) of the rooftop units heating and ventilation units only for the Gym and Locker Rooms. The remaining Seventeen (17) are direct expansion units, (16) gas-fired for heat. These rooftop units' range in manufacturer with AAON, Carrier, Trane, and Sterling (H&V) all represented. These units range from 5 to 110 tons with a total of 516.5 tons of cooling. Within this measure, DCO Energy is evaluating 14 units for replacement, approxemently 479 tons of cooling. These units were identified to be in poor condition and past ASHREA useful life of 15 years.

Indian Hills High School – 25 total rooftop units currently serve this high school. Three (3) of the rooftop units are heating and ventilation units only for the Gym and Locker Rooms. The remaining Seventeen (22) are direct expansion units, (20) gas-fired for heat. These rooftop units' range in manufacturer with AAON, Carrier, Trane, and Daiken (H&V) all represented. These units range from 3 to 40 tons with a total of 308 tons of cooling. Within this measure, DCO Energy is evaluating 15 units for replacement, approxemently 268 tons of cooling. These units were identified to be in poor condition and past ASHREA useful life of 15 years.

Existing roof top units at Ramapo High School



Existing roof top units at Indian Hills High School

Scope of Work

The following RTUs will be replaced with high efficiency constant volume units:

RTU Replacement Scope of Work					
BUILDING	CATEGORY	AREA SERVED	TONS	QUANTITY	SPECIFICATIONS
Ramapo High School	RTU-1-2A	712-725, 812-818	110	1	MERV-13 Filters, CO2 DCV Included, Dehumidification (Hot Gas Re-heat), Bacnet Com Cards
	RTU-1-2B	702-710, 802-808	110	1	
	RTU-1H	109-117	30	1	
	RTU-3A	TV Studio	30	1	
	RTU-2A	Band/Choir	25	1	
	RTU-1A	Auditorium	75	1	
	RTU-1-D	900	6	1	MERV-13 Filters, Dehumidification, Bacnet Com Cards
	RTU-1	901-905	15	1	
	RTU-2D	909	15	1	
	RTU-1C	Library	27	1	
	RTU-3C	CST	8.5	1	
	RTU-2C	Guidance	12.5	1	
	RTU-209-211	209-211	5	1	
	RTU-4C	217-218	10	1	
Indian Hills High School	RTU-20	BOE	31	1	MERV-13 Filters, CO2 DCV Included, Dehumidification (Hot Gas Re-heat), Bacnet Com Cards
	RTU-21	BOE	25	1	
	RTU-02	Science 121-125	25	1	
	RTU-01	Science 220- 224	40	1	
	RTU-04	Science 201-201A-203	25	1	
	RTU-05	Science 205-207-207A	20	1	
	AC-3	406-404	8	1	
	RTU-8	Bio labs 804, 808	15	1	
	RTU-10	Science LL 709,711,807	15	1	
	RTU-6	CST & IDF2	7.5	1	MERV-13 Filters, Dehumidification, Bacnet Com Cards
	RTU-03	Math Lower Floor	6	1	
	RTU-11	Library	25	1	
	RTU-9	Bio- Chem 705, 707, 715	10	1	
	RTU-07	Multimedia	12.5	1	
	RTU-12	SGI 619, 621	3	1	

Ramapo High School and Indian Hills High School

- Take pre-construction air balancing readings on the units to be replaced (Totals Only)
- Lockout/Tag out the electrical power going to existing equipment to be replaced
- Disconnect the electrical power and control wiring and safe off for reuse
- Disconnect gas piping and safe off for reuse (Gas fired units only)
- Disconnect duct work from the existing units (where applicable)

- Using a crane, remove the existing equipment from the roof and discard off site
- Using a crane, set new adaptor curb into place
- Using a crane, set the new rooftop units onto the new adaptor curbs
- Connect the existing electrical power wiring to the new rooftop units that were replaced
- Furnish and install new unit thermostat to replace existing
- Furnish and install new gas piping to connect the new rooftop units to the existing gas piping
- Furnish and install new ductwork to adapt the existing ductwork to the new unit (where applicable).
- Ductwork will be internal lined and outside just sealed like the existing.
- Provide factory startup of the new rooftop units
- Provide final air balancing and adjust to match pre-construction readings (Totals Only)
- Provide training on the equipment for all the owner's authorized employees

ECM Calculations

Energy Savings from the installation of high efficiency rooftop units were calculated using BPU protocols. The calculations are shown below.

CALCULATED SAVINGS									
RTU Replacement - VFD Fan Savings									
BUILDING	SYSTEM	Areas Served	QTY	Type	Fan QTY	EXISTING FAN HP	PROPOSED FAN HP	EXISTING MOTOR EFFICIENCY (Nbase)	REPLACEMENT MOTOR EFFICIENCY (Nprem)
Ramapo High School	RTU-1-2A	712-725, 812-818	1	DX/Gas Fired	1	10.0	10.0	88.7%	91.7%
	RTU-1-2B	702-710, 802-808	1	DX/Gas Fired	1	10.0	10.0	88.7%	91.7%
	RTU-1H	109-117	1	DX/Gas Fired	1	6.0	6.0	86.5%	89.5%
	RTU-3A	TV Studio	1	DX/Gas Fired	1	10.0	10.0	88.7%	91.7%
	RTU-2A	Band/Choir	1	DX/Gas Fired	1	10.0	10.0	88.7%	91.7%
	RTU-1A	Auditorium	1	DX/Gas Fired	1	20.0	20.0	90.0%	93.0%
	RTU-1-D	900	1	DX/Gas Fired	1	2.0	2.0	83.5%	86.5%
	RTU-1	901-905	1	DX/Gas Fired	1	5.0	5.0	86.5%	89.5%
	RTU-2D	909	1	DX/Gas Fired	1	5.0	5.0	86.5%	89.5%
	RTU-1C	Library	1	DX/Gas Fired	1	10.0	10.0	88.7%	91.7%
	RTU-3C	CST	1	DX/Gas Fired	1	3.0	3.0	86.5%	89.5%
	RTU-2C	Guidance	1	DX Only	1	3.0	3.0	86.5%	89.5%
	RTU-209-211	209-211	1	DX/Gas Fired	1	2.0	2.0	83.5%	86.5%
	RTU-4C	217-218	1	DX Only	1	3.0	3.0	86.5%	89.5%
	HV-1D	Boys Locker Room	1	Gas Fired Furnace	1	5.0	5.0	86.5%	89.5%
	HV-3D	Gym North	1	Gas Fired Furnace	1	15.0	15.0	89.4%	92.4%
	HV-4D	Gym South	1	Gas Fired Furnace	1	15.0	15.0	89.4%	92.4%
	0	0	0						
Indian Hills High School	RTU-20	BOE	1	DX/Gas Fired	1	10.0	10.0	88.7%	91.7%
	RTU-21	BOE	1	DX/Gas Fired	1	10.0	10.0	88.7%	91.7%
	RTU-02	Science 121-125	1	DX/Gas Fired	1	10.0	10.0	88.7%	91.7%
	RTU-01	Science 220- 224	1	DX/Gas Fired	1	10.0	10.0	88.7%	91.7%
	RTU-04	Science 201-201A-203	1	DX/Gas Fired	1	10.0	10.0	88.7%	91.7%
	RTU-05	Science 205-207-207A	1	DX/Gas Fired	1	7.5	7.5	88.7%	91.7%
	AC-3	406-404	1	DX/Gas Fired	1	3.0	3.0	86.5%	89.5%
	RTU-8	Bio labs 804, 808	1	DX/Gas Fired	1	5.0	5.0	86.5%	89.5%
	RTU-10	Science LL 709,711,807	1	DX/Gas Fired	1	5.0	5.0	86.5%	89.5%
	RTU-6	CST & IDF2	1	DX Only	1	5.0	5.0	86.5%	89.5%
	RTU-03	Math Lower Floor	1	DX Only	1	2.0	2.0	83.5%	86.5%
	RTU-11	Library	1	DX/Gas Fired	1	10.0	10.0	88.7%	91.7%
	RTU-9	Bio- Chem 705, 707, 715	1	DX/Gas Fired	1	3.5	3.5	86.5%	89.5%
	RTU-07	Multimedia	1	DX Only	1	4.0	4.0	86.5%	89.5%
	RTU-12	SGI 619, 621	1	DX Only	1	0.5	0.5	83.5%	86.5%
	RTU-1	Nurse	1	DX/Gas Fired	1	2.0	2.0	84.5%	86.5%
	RTU-2	Conference Room	1	DX/Gas Fired	1	2.0	2.0	84.5%	86.5%
	RTU-5	600 & 803	1	DX/Gas Fired	1	2.0	2.0	84.5%	86.5%

RTU Replacement - VFD Fan Savings

BUILDING	SYSTEM	Areas Served	LF	CF	IFvfd	HRS	ΔkW	PREM. MOTOR DEMAND SAVINGS (kW)	PREM. MOTOR ELECTRIC SAVINGS (kWh)	TOTAL DEMAND SAVINGS (kW)	TOTAL ELECTRIC SAVINGS (kWh)
Ramapo High School	RTU-1-2A	712-725, 812-818	0.75	0.74	1.0	3,391	0.28	0.20	700	0.2	700
	RTU-1-2B	702-710, 802-808	0.75	0.74	1.0	3,391	0.28	0.20	700	0.2	700
	RTU-1H	109-117	0.75	0.74	1.0	3,391	0.17	0.13	441	0.1	441
	RTU-3A	TV Studio	0.75	0.74	1.0	3,391	0.28	0.20	700	0.2	700
	RTU-2A	Band/Choir	0.75	0.74	1.0	3,391	0.28	0.20	700	0.2	700
	RTU-1A	Auditorium	0.75	0.74	1.0	3,391	0.53	0.40	1,360	0.4	1,360
	RTU-1-D	900	0.75	0.74	1.0	2,745	0.06	0.05	128	0.0	128
	RTU-1	901-905	0.75	0.74	1.0	2,745	0.14	0.11	298	0.1	298
	RTU-2D	909	0.75	0.74	1.0	2,745	0.14	0.11	298	0.1	298
	RTU-1C	Library	0.75	0.74	1.0	3,391	0.28	0.20	700	0.2	700
	RTU-3C	CST	0.75	0.74	1.0	2,745	0.09	0.06	179	0.1	179
	RTU-2C	Guidance	0.75	0.74	1.0	2,745	0.09	0.06	179	0.1	179
	RTU-209-211	209-211	0.75	0.74	1.0	2,745	0.06	0.05	128	0.0	128
	RTU-4C	217-218	0.75	0.74	1.0	2,745	0.09	0.06	179	0.1	179
	HV-1D	Boys Locker Room	0.75	0.74	1.0	2,745	0.14	0.11	298	0.1	298
	HV-3D	Gym North	0.75	0.74	1.0	3,391	0.41	0.30	1,034	0.3	1,034
	HV-4D	Gym South	0.75	0.74	1.0	3,391	0.41	0.30	1,034	0.3	1,034
	0	0	0.75	0.74	1.0		0.00	0.00	0	0.0	0
Indian Hills High School	RTU-20	BOE	0.75	0.74	1.0	3,391	0.28	0.20	700	0.2	700
	RTU-21	BOE	0.75	0.74	1.0	3,391	0.28	0.20	700	0.2	700
	RTU-02	Science 121-125	0.75	0.74	1.0	3,391	0.28	0.20	700	0.2	700
	RTU-01	Science 220- 224	0.75	0.74	1.0	3,391	0.28	0.20	700	0.2	700
	RTU-04	Science 201-201A-203	0.75	0.74	1.0	3,391	0.28	0.20	700	0.2	700
	RTU-05	Science 205-207-207A	0.75	0.74	1.0	3,391	0.21	0.15	525	0.2	525
	AC-3	406-404	0.75	0.74	1.0	2,745	0.09	0.06	179	0.1	179
	RTU-8	Bio labs 804, 808	0.75	0.74	1.0	2,745	0.14	0.11	298	0.1	298
	RTU-10	Science LL 709,711,807	0.75	0.74	1.0	2,745	0.14	0.11	298	0.1	298
	RTU-6	CST & IDF2	0.75	0.74	1.0	2,745	0.14	0.11	298	0.1	298
	RTU-03	Math Lower Floor	0.75	0.74	1.0	2,745	0.06	0.05	128	0.0	128
	RTU-11	Library	0.75	0.74	1.0	3,391	0.28	0.20	700	0.2	700
	RTU-9	Bio- Chem 705, 707, 715	0.75	0.74	1.0	2,745	0.10	0.07	208	0.1	208
	RTU-07	Multimedia	0.75	0.74	1.0	2,745	0.12	0.09	238	0.1	238
	RTU-12	SGI 619, 621	0.75	0.74	1.0	2,745	0.02	0.01	32	0.0	32
	RTU-1	Nurse	0.75	0.74	1.0	2,745	0.04	0.03	84	0.0	84
	RTU-2	Conference Room	0.75	0.74	1.0	2,745	0.04	0.03	84	0.0	84
	RTU-5	600 & 803	0.75	0.74	1.0	2,745	0.04	0.03	84	0.0	84

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
LF	Fixed	0.75	1
η_{base}	Fixed	ASHRAE 90.1-2016 Baseline Efficiency Table	ASHRAE
η_{prem}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
IF_{VFD}	Fixed	1.0 or 0.9	3
Efficiency - η_{ee}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
CF	Fixed	0.74	1
HRS	Fixed	Annual Operating Hours Table	1

Annual Operating Hours Table

Motor Horsepower	Operating Hours, HRS
1 to 5 HP	2,745
6 to 20 HP	3,391
21 to 50 HP	4,067
51 to 100 HP	5,329
101 to 200 HP	5,200

NEMA ASHRAE 90.1-2016 Motor Efficiency Table – General Purpose Subtype I (Adapted from Table 10.8-1)

Motor Horsepower	1200 RPM (6 pole)		1800 RPM (4 pole)		3600 RPM (2 pole)	
	ODP	TEFC	ODP	TEFC	ODP	TEFC
1	.825	.825	.855	.855	.77	.77
1.5	.865	.875	.865	.865	.84	.84
2	.875	.885	.865	.865	.855	.855
3	.885	.895	.895	.895	.855	.865
5	.895	.895	.895	.895	.865	.885
7.5	.902	.91	.91	.917	.885	.895
10	.917	.91	.917	.917	.895	.902
15	.917	.917	.93	.924	.902	.91
20	.924	.917	.93	.930	.91	.91
25	.93	.93	.936	.936	.917	.917
30	.936	.93	.941	.936	.917	.917
40	.941	.941	.941	.941	.924	.924
50	.941	.941	.945	.945	.93	.93
60	.945	.945	.95	.950	.936	.936
75	.945	.945	.95	.954	.936	.936
100	.95	.95	.954	.954	.936	.941
125	.95	.95	.954	.954	.941	.95
150	.954	.958	.958	.958	.941	.95
200	.954	.958	.958	.962	.95	.954

CALCULATED SAVINGS

RTU Replacement - Cooling Savings

BUILDING	SYSTEM	Areas Served	Existing Qty	Tons Per Unit	Total Existing Tons	EERb / SEERb	Proposed Qty	Tons Per Unit	Total Proposed Tons	EERq / SEERq	CF	EFLH Cooling	Demand Savings (kW)	Energy Savings (kWh)
Ramapo High School	RTU-1-2A	712-725, 812-818	1	110	110.0	8.0	1	110.0	110.0	11.8	0.5	466	26.6	24,761
	RTU-1-2B	702-710, 802-808	1	110	110.0	8.0	1	110.0	110.0	11.8	0.5	466	26.6	24,761
	RTU-1H	109-117	1	30	30.0	8.3	1	30.0	30.0	12.6	0.5	466	7.3	6,801
	RTU-3A	TV Studio	1	30	30.0	8.3	1	30.0	30.0	12.6	0.5	466	7.3	6,801
	RTU-2A	Band/Choir	1	25	25.0	7.8	1	25.0	25.0	12.8	0.5	466	7.6	7,117
	RTU-1A	Auditorium	1	75	75.0	8.3	1	75.0	75.0	12.1	0.5	466	17.4	16,175
	RTU-1-D	900	1	6	6.0	9.1	1	6.0	6.0	12.0	0.5	466	1.0	891
	RTU-1	901-905	1	15	15.0	8.3	1	15.0	15.0	12.0	0.5	466	3.3	3,068
	RTU-2D	909	1	15	15.0	8.3	1	15.0	15.0	12.0	0.5	466	3.3	3,068
	RTU-1C	Library	1	27	27.0	8.0	1	27.0	27.0	11.5	0.5	466	6.2	5,744
	RTU-3C	CST	1	8.5	8.5	9.1	1	8.5	8.5	12.0	0.5	466	1.4	1,262
	RTU-2C	Guidance	1	12.5	12.5	8.0	1	12.5	12.5	12.2	0.5	466	3.2	3,008
	RTU-209-211	209-211	1	5	5.0	9.3	1	5.0	5.0	12.5	0.5	466	0.8	774
	RTU-4C	217-218	1	10	10.0	8.0	1	10.0	10.0	12.0	0.5	466	2.5	2,330
	HV-1D	Boys Locker Room	1	0	0.0	N/A	1	0.0	0.0	N/A	0.5	N/A	0.0	0
	HV-3D	Gym North	1	0	0.0	N/A	1	0.0	0.0	N/A	0.5	N/A	0.0	0
	HV-4D	Gym South	1	0	0.0	N/A	1	0.0	0.0	N/A	0.5	N/A	0.0	0
	0	0	0	0	0.0		0	0.0	0.0		0.5		0.0	0
Indian Hills High School	RTU-20	BOE	1	31	31.0	8.4	1	31.0	31.0	12.6	0.5	466	7.4	6,855
	RTU-21	BOE	1	25	25.0	8.4	1	25.0	25.0	12.8	0.5	466	6.1	5,701
	RTU-02	Science 121-125	1	25	25.0	7.8	1	25.0	25.0	12.8	0.5	466	7.6	7,117
	RTU-01	Science 220- 224	1	40	40.0	8.1	1	40.0	40.0	12.2	0.5	466	10.0	9,349
	RTU-04	Science 201-201A-203	1	25	25.0	7.8	1	25.0	25.0	12.8	0.5	466	7.6	7,117
	RTU-05	Science 205-207-207A	1	20	20.0	7.8	1	20.0	20.0	12.8	0.5	466	6.1	5,693
	AC-3	406-404	1	8	8.0	7.7	1	8.0	8.0	12.5	0.5	466	2.4	2,255
	RTU-8	Bio labs 804, 808	1	15	15.0	8.1	1	15.0	15.0	12.0	0.5	466	3.6	3,391
	RTU-10	Science LL 709,711,807	1	15	15.0	8.1	1	15.0	15.0	12.0	0.5	466	3.6	3,391
	RTU-6	CST & IDF2	1	7.5	7.5	7.6	1	7.5	7.5	12.0	0.5	466	2.2	2,038
	RTU-03	Math Lower Floor	1	6	6.0	7.6	1	6.0	6.0	12.0	0.5	466	1.7	1,630
	RTU-11	Library	1	25	25.0	7.2	1	25.0	25.0	11.6	0.5	466	8.0	7,419
	RTU-9	Bio- Chem 705, 707, 715	1	10	10.0	9.1	1	10.0	10.0	12.0	0.5	466	1.6	1,485
	RTU-07	Multimedia	1	12.5	12.5	9.1	1	12.5	12.5	12.0	0.5	466	2.0	1,856
	RTU-12	SGI 619, 621	1	3	3.0	8.2	1	3.0	3.0	11.0	0.5	466	0.6	528
	RTU-1	Nurse	1	5	5.0	10.3	1	5.0	5.0	12.0	0.5	466	0.4	377
	RTU-2	Conference Room	1	5	5.0	10.3	1	5.0	5.0	12.2	0.5	466	0.4	415
	RTU-5	600 & 803	1	6	6.0	10.3	1	6.0	6.0	12.5	0.5	466	0.6	564

Algorithms

Air Conditioning Algorithms:

Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * ($1/EER_b - 1/EER_q$) * $EFLH_c$

Peak Demand Savings (kW) = N * Tons * 12 kBtuh/Ton * ($1/EER_b - 1/EER_q$) * CF

(5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value is based on existing measured usage and determined as the average number of operating hours during the peak window period.

$EFLH_{c\ or\ h}$ = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off-peak periods.

Summary of Inputs

HVAC and Heat Pumps

Component	Type	Value	Source
Tons	Variable	Rated Capacity, Tons	Application
EER_b	Variable	See Table below	1
EER_q	Variable	ARI/AHRI or AHAM Values	Application
CF	Fixed	50%	2
$EFLH_{(c\ or\ h)}$	Variable	See Tables below	3

Definition of Variables

N = Number of units

Tons = Rated cooling capacity of unit.This value comes from ARI/AHRI or AHAM rating or manufacturer data.

EER_b = Energy Efficiency Ratio of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER should be used in place of EER.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

EER_q = Energy Efficiency Ratio of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 (5.4 tons) BtuH, SEER should be used in place of EER.

COP_q = Coefficient of Performance of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 BtuH

HVAC Baseline Efficiencies Table – New Construction/EUL/RoF

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2016
Unitary HVAC/Split Systems and Single Package, Air Cooled	
<=5.4 tons, split	14 SEER
<=5.4 tons, single	14 SEER
>5.4 to 11.25 tons	11.0 EER, 12.7 IEER
>11.25 to 20 tons	10.8 EER, 12.2 IEER
> 21 to 63 tons	9.8 EER, 11.4 IEER
>63 Tons	9.5 EER, 11.0 IEER
Air Cooled Heat Pump Systems, Split System and Single Package	
<=5.4 tons, split	14 SEER, 8.2 HSPF
<=5.4 tons, single	14 SEER, 8.0 HSPF
>5.4 to 11.25 tons	10.8 EER, 12 IEER, 3.3 heating COP
>11.25 to 20 tons	10.4 EER, 11.4 IEER, 3.2 heating COP
>= 21	9.3 EER, 10.4 IEER, 3.2 heating COP
Water Source Heat Pumps (water to air, water loop)	
<=1.4 tons	12.2 EER, 4.3 heating COP
>1.4 to 5.4 tons	13.0 EER, 4.3 heating COP
>5.4 to 11.25 tons	13.0 EER, 4.3 heating COP
Ground Water Source Heat Pumps <=11.25 tons	18.0 EER, 3.7 heating COP
Ground Source Heat Pumps (brine to air, ground loop) <=11.25 tons	14.1 EER, 3.2 heating COP
Package Terminal Air Conditioners[37]	14.0 – (0.300 * Cap/1,000), EER
Package Terminal Heat Pumps	14.0 – (0.300 * Cap/1,000), EER 3.7 – (0.052 * Cap/1,000), heating COP
Single Package Vertical Air Conditioners	
<=5.4 tons	10.0 EER
>5.4 to 11.25 tons	10.0 EER
>11.25 to 20 tons	10.0 EER
Single Package Vertical Heat Pumps	
<=5.4 tons	10.0 EER, 3.0 heating COP
>5.4 to 11.25 tons	10.0 EER, 3.0 heating COP
>11.25 to 20 tons	10.0 EER, 3.0 heating COP

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

CALCULATED SAVINGS

RTU Replacement - Economizer Savings

BUILDING	SYSTEM	Areas Served	QUANTITY	Cap (Tons)	D^kwh/ton	Demand Savings (kW)	Energy Savings (kWh)
Ramapo High School	RTU-1-2A	712-725, 812-818	1	110	0	0	0
	RTU-1-2B	702-710, 802-808	1	110	0	0	0
	RTU-1H	109-117	1	30	0	0	0
	RTU-3A	TV Studio	1	30	0	0	0
	RTU-2A	Band/Choir	1	25	0	0	0
	RTU-1A	Auditorium	1	75	0	0	0
	RTU-1-D	900	1	6	42	0	252
	RTU-1	901-905	1	15	42	0	630
	RTU-2D	909	1	15	42	0	630
	RTU-1C	Library	1	27	42	0	1,134
	RTU-3C	CST	1	8.5	42	0	357
	RTU-2C	Guidance	1	12.5	42	0	525
	RTU-209-211	209-211	1	5	42	0	210
	RTU-4C	217-218	1	10	42	0	420
	HV-1D	Boys Locker Room	1	0	N/A	0	0
	HV-3D	Gym North	1	0	N/A	0	0
	HV-4D	Gym South	1	0	N/A	0	0
	0	0	0	0		0	0
Indian Hills High School	RTU-20	BOE	1	31	0	0	0
	RTU-21	BOE	1	25	0	0	0
	RTU-02	Science 121-125	1	25	0	0	0
	RTU-01	Science 220- 224	1	40	0	0	0
	RTU-04	Science 201-201A-203	1	25	42	0	1050
	RTU-05	Science 205-207-207A	1	20	42	0	840
	AC-3	406-404	1	8	42	0	336
	RTU-8	Bio labs 804, 808	1	15	42	0	630
	RTU-10	Science LL 709,711,807	1	15	42	0	630
	RTU-6	CST & IDF2	1	7.5	42	0	315
	RTU-03	Math Lower Floor	1	6	42	0	252
	RTU-11	Library	1	25	42	0	1050
	RTU-9	Bio- Chem 705, 707, 715	1	10	42	0	420
	RTU-07	Multimedia	1	12.5	42	0	525
	RTU-12	SGI 619, 621	1	3	42	0	126
	RTU-1	Nurse	1	5	42	0	210
	RTU-2	Conference Room	1	5	42	0	210
	RTU-5	600 & 803	1	6	42	0	252

Dual Enthalpy Economizers

The following algorithm details savings for dual enthalpy economizers. They are to be used to determine electric energy savings between baseline standard units and the high efficiency units promoted in the program. The baseline condition is assumed to be a rooftop unit with fixed outside air (no economizer). The high efficiency units are equipped with sensors that monitor the enthalpy of outside air and return air and modulate the outside air damper to optimize energy performance.

Algorithms

Electric energy savings (kWh/yr) = N * Tons * (ΔkWh/ton)

Peak Demand Savings (kW) = 0[38] kW

Definition of Variables

N = Number of units

Tons = Rated capacity of the cooling system retrofitted with an economizer

ΔkWh/ton = Stipulated per building type electricity energy savings per ton of cooling system retrofitted with an economizer

Summary of Inputs

Dual Enthalpy Economizers

Component	Type	Value	Source
N	Variable		Application
Tons	Variable	Rated Capacity, Tons	Application
ΔkWh/ton	Fixed	See Table Below	1

Savings per Ton of Cooling System

Building Type	Savings (ΔkWh/ton)
Assembly	27
Big Box Retail	152
Fast Food Restaurant	39
Full Service Restaurant	31
Light Industrial	25
Primary School	42
Small Office	186
Small Retail	95
Religious	6
Warehouse	2
Other	61

RTU Replacement - Heating Savings											
BUILDING NAME	SYSTEM	Areas Served	Qty	Estimated Existing Efficiency	Efficiency Units	Baseline RTU Rated Input MBH	Baseline Plant Rated Input MBH (CAPYbi)	Qualifying RTU Capacity MBH	Qualifying Plant Capacity (CAPYqi)	Qualifying RTU Efficiency	Efficiency Units
Ramapo High School	RTU-1-2A	712-725, 812-818	1	75.3%	%AFUE	860	860	860	860	80.0%	%AFUE
	RTU-1-2B	702-710, 802-808	1	75.3%	%AFUE	860	860	860	860	80.0%	%AFUE
	RTU-1H	109-117	1	75.3%	%AFUE	780	780	780	780	80.0%	%AFUE
	RTU-3A	TV Studio	1	75.3%	%AFUE	540	540	540	540	80.0%	%AFUE
	RTU-2A	Band/Choir	1	75.3%	%AFUE	390	390	390	390	80.0%	%AFUE
	RTU-1A	Auditorium	1	75.3%	%AFUE	1101	1,101	1101	1,101	80.0%	%AFUE
	RTU-1-D	900	1	75.3%	%AFUE	72	72	72	72	80.0%	%AFUE
	RTU-1	901-905	1	75.3%	%AFUE	275	275	275	275	80.0%	%AFUE
	RTU-2D	909	1	75.3%	%AFUE	275	275	275	275	80.0%	%AFUE
	RTU-1C	Library	1	75.3%	%AFUE	350	350	350	350	80.0%	%AFUE
	RTU-3C	CST	1	75.3%	%AFUE	125	125	125	125	80.0%	%AFUE
	RTU-2C	Guidance	1	80.0%	%AFUE	80	80	80	80	80.0%	%AFUE
	RTU-209-211	209-211	1	75.3%	%AFUE	115	115	115	115	80.0%	%AFUE
	RTU-4C	217-218	1	N/A	N/A	0	0	0	0	80.0%	%AFUE
	HV-1D	Boys Locker Room	1	75.3%	%AFUE	400	400	400	400	81.0%	%AFUE
	HV-3D	Gym North	1	75.3%	%AFUE	800	800	800	800	81.0%	%AFUE
	HV-4D	Gym South	1	75.3%	%AFUE	800	800	800	800	81.0%	%AFUE
	0	0	0		Et		0		0		Et
Indian Hills High School	RTU-20	BOE	1	75.5%	%AFUE	540	540	540	540	80.0%	%AFUE
	RTU-21	BOE	1	75.5%	%AFUE	480	480	480	480	80.0%	%AFUE
	RTU-02	Science 121-125	1	75.3%	%AFUE	270	270	270	270	80.0%	%AFUE
	RTU-01	Science 220- 224	1	75.3%	%AFUE	780	780	780	780	80.0%	%AFUE
	RTU-04	Science 201-201A-203	1	75.3%	%AFUE	400	400	400	400	80.0%	%AFUE
	RTU-05	Science 205-207-207A	1	75.3%	%AFUE	390	390	390	390	80.0%	%AFUE
	AC-3	406-404	1	75.3%	%AFUE	180	180	180	180	80.0%	%AFUE
	RTU-8	Bio labs 804, 808	1	75.3%	%AFUE	270	270	270	270	80.0%	%AFUE
	RTU-10	Science LL 709,711,807	1	75.3%	%AFUE	270	270	270	270	80.0%	%AFUE
	RTU-6	CST & IDF2	1	N/A	N/A	0	0	0	0	N/A	N/A
	RTU-03	Math Lower Floor	1	N/A	N/A	0	0	0	0	N/A	N/A
	RTU-11	Library	1	75.8%	%AFUE	350	350	350	350	80.0%	%AFUE
	RTU-9	Bio- Chem 705, 707, 715	1	N/A	N/A	0	0	0	0	N/A	N/A
	RTU-07	Multimedia	1	N/A	N/A	0	0	0	0	N/A	N/A
	RTU-12	SGI 619, 621	1	N/A	N/A	0	0	0	0	N/A	N/A
	RTU-1	Nurse	1	78.2%	%AFUE	80	80	80	80	80.0%	%AFUE
	RTU-2	Conference Room	1	78.2%	%AFUE	98	98	98	98	80.0%	%AFUE
	RTU-5	600 & 803	1	78.2%	%AFUE	96	96	96	96	80.0%	%AFUE

RTU Replacement - Heating Savings								
BUILDING NAME	**SYSTEM**	**Areas Served**	**Qty**	**EFLH**	**Conversion of BTU to therms**	**Baseline Gas Use (Therms)**	**Proposed Gas Use (Therms)**	**Annual Gas Savings (Therms)**
Ramapo High School	RTU-1-2A	712-725, 812-818	1	901	100,000	10,294	9,686	609
	RTU-1-2B	702-710, 802-808	1	901	100,000	10,294	9,686	609
	RTU-1H	109-117	1	901	100,000	9,337	8,785	552
	RTU-3A	TV Studio	1	901	100,000	6,464	6,082	382
	RTU-2A	Band/Choir	1	901	100,000	4,668	4,392	276
	RTU-1A	Auditorium	1	901	100,000	13,179	12,400	779
	RTU-1-D	900	1	901	100,000	862	811	51
	RTU-1	901-905	1	901	100,000	3,292	3,097	195
	RTU-2D	909	1	901	100,000	3,292	3,097	195
	RTU-1C	Library	1	901	100,000	4,190	3,942	248
	RTU-3C	CST	1	901	100,000	1,496	1,408	88
	RTU-2C	Guidance	1	901	100,000	901	901	-
	RTU-209-211	209-211	1	901	100,000	1,377	1,295	81
	RTU-4C	217-218	1	901	100,000	-	-	-
	HV-1D	Boys Locker Room	1	901	100,000	4,788	4,449	339
	HV-3D	Gym North	1	901	100,000	9,576	8,899	677
	HV-4D	Gym South	1	901	100,000	9,576	8,899	677
	0	0	0		100,000	-	-	-
Indian Hills High School	RTU-20	BOE	1	901	100,000	6,443	6,082	361
	RTU-21	BOE	1	901	100,000	5,727	5,406	321
	RTU-02	Science 121-125	1	901	100,000	3,232	3,041	191
	RTU-01	Science 220- 224	1	901	100,000	9,337	8,785	552
	RTU-04	Science 201-201A-203	1	901	100,000	4,788	4,505	283
	RTU-05	Science 205-207-207A	1	901	100,000	4,668	4,392	276
	AC-3	406-404	1	901	100,000	2,155	2,027	127
	RTU-8	Bio labs 804, 808	1	901	100,000	3,232	3,041	191
	RTU-10	Science LL 709,711,807	1	901	100,000	3,232	3,041	191
	RTU-6	CST & IDF2	1	901	100,000	-	-	-
	RTU-03	Math Lower Floor	1	901	100,000	-	-	-
	RTU-11	Library	1	901	100,000	4,161	3,942	219
	RTU-9	Bio- Chem 705, 707, 715	1	901	100,000	-	-	-
	RTU-07	Multimedia	1	901	100,000			
	RTU-12	SGI 619, 621	1	901	100,000	-	-	-
	RTU-1	Nurse	1	901	100,000	921	901	20
	RTU-2	Conference Room	1	901	100,000	1,129	1,104	25
	RTU-5	600 & 803	1	901	100,000	1,106	1,081	24

Algorithms

Fuel Savings (MMBtu/yr) = Cap_{in} * $EFLH_h$ * ((Eff_q/Eff_b)-1) / 1000 kBtu/MMBtu

Definition of Variables

Cap_{in} = Input capacity of qualifying unit in kBtu/hr

$EFLH_h$ = The Equivalent Full Load Hours of operation for the average unit during the heating season in hours

Eff_b = Furnace Baseline Efficiency

Eff_q = Furnace Proposed Efficiency

1000 = Conversion from kBtu to MMBtu

Summary of Inputs

Prescriptive Furnaces

Component	Type	Value	Source
Cap_{in}	Variable		Application
$EFLH_h$	Fixed	See Table Below	1
Eff_q	Variable		Application
Eff_b	Fixed	See Table Below	2

$EFLH_h$ Table

Facility Type	Heating EFLH
Assembly	603
Auto repair	1910
Dormitory	465
Hospital	3366
Light industrial	714
Lodging – Hotel	1077
Lodging – Motel	619
Office – large	2034
Office – small	431
Other	681
Religious worship	722

Facility Type	Heating EFLH
Restaurant – fast food	813
Restaurant – full service	821
Retail – big box	191
Retail – Grocery	191
Retail – small	545
Retail – large	2101
School – Community college	1431
School – postsecondary	1191
School – primary	840
School – secondary	901
Warehouse	452

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Heating	757	723	503
High-rise, Heating	526	395	219

Baseline Furnace Efficiencies (Eff_b)

Furnace Type	Size Category (kBtu input)	Standard 90.1-2016
Gas Fired	< 225	78% AFUE or 80% Et
	≥ 225	80% Et
Oil Fired	< 225	78% AFUE
	≥ 225	81% Et

RTU Replacement - Total Savings

BUILDING NAME	SYSTEM	Areas Served	Annual Electric Savings (kWh)	Total Electric Savings (kWh)	Annual Demand Savings (kW)	Total Demand Savings (kW)	Annual Gas Savings (Therms)	Total Gas Savings (Therms)
Ramapo High School	RTU-1-2A	712-725, 812-818	25,461	117,404	27	116	609	4,065
	RTU-1-2B	702-710, 802-808	25,461		27		609	
	RTU-1H	109-117	7,242		7		552	
	RTU-3A	TV Studio	7,501		8		382	
	RTU-2A	Band/Choir	7,817		8		276	
	RTU-1A	Auditorium	17,535		18		779	
	RTU-1-D	900	1,271		1		51	
	RTU-1	901-905	3,995		3		195	
	RTU-2D	909	3,995		3		195	
	RTU-1C	Library	7,578		6		248	
	RTU-3C	CST	1,798		1		88	
	RTU-2C	Guidance	3,712		3		-	
	RTU-209-211	209-211	1,111		1		81	
	RTU-4C	217-218	2,929		3		-	
	HV-1D	Boys Locker Room	-		-		-	
	HV-3D	Gym North	-		-		-	
	HV-4D	Gym South	-		-		-	
	0	0	-		-		-	
Indian Hills High School	RTU-20	BOE	7,554	78,400	8	73	361	2,712
	RTU-21	BOE	6,401		6		321	
	RTU-02	Science 121-125	7,817		8		191	
	RTU-01	Science 220- 224	10,049		10		552	
	RTU-04	Science 201-201A-203	8,867		8		283	
	RTU-05	Science 205-207-207A	7,058		6		276	
	AC-3	406-404	2,769		2		127	
	RTU-8	Bio labs 804, 808	4,319		4		191	
	RTU-10	Science LL 709,711,807	4,319		4		191	
	RTU-6	CST & IDF2	2,651		2		-	
	RTU-03	Math Lower Floor	2,010		2		-	
	RTU-11	Library	9,169		8		219	
	RTU-9	Bio- Chem 705, 707, 715	2,113		2		-	
	RTU-07	Multimedia	2,619		2		-	
	RTU-12	SGI 619, 621	686		1		-	
	RTU-1	Nurse	-		-		-	
	RTU-2	Conference Room	-		-		-	
	RTU-5	600 & 803	-		-		-	

ECM 7 –Split System Replacement

RAMAPO INDIAN HILLS RHSD

✓	ECM evaluated but not included
✓	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
7	Split System Replacement	✓	✓

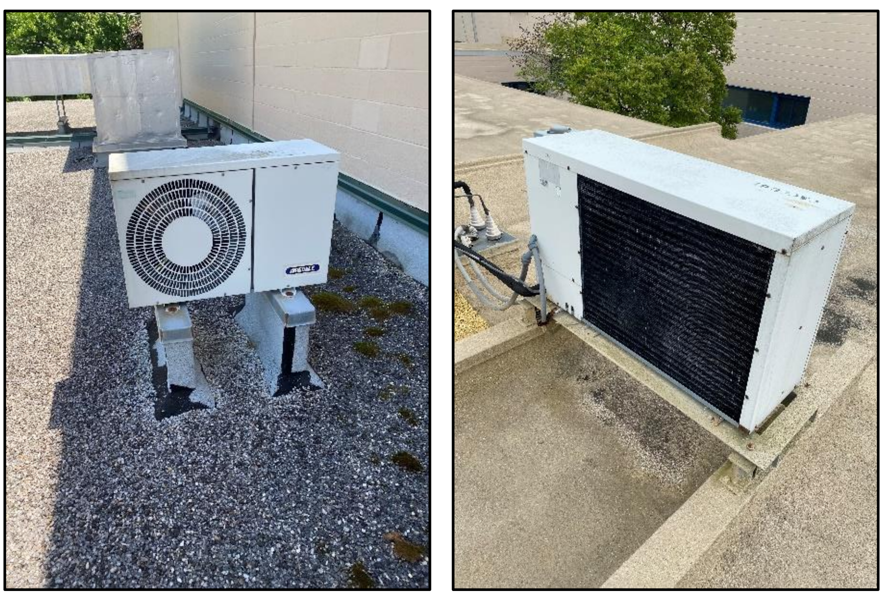
An air conditioning unit is one of the most energy-intensive units in any facility. Technology has made leaps and bounds in the past several years in making these machines more efficient. air conditioning unit efficiency is rated by how much electrical energy is used to produce an amount of cooling. This is expressed in kilowatts per ton of cooling (kW/ton). An older machine may be as high as 1.2 kW/ton, whereas a new air conditioning unit r may be as low as 0.9 kW/ton or even less. A new machine uses less electrical power to produce the same amount of cooling. In addition, installing new high efficient rooftop air conditioners will include:

- Condensing units that drain to the interior of the building
- Improved insulation
- Duct dampers which prevent off-cycle losses due to convection loops that lose heat
- More efficient modulating compressor and improved humidity control if the indoor blower or air handler is also variable speed

Existing Conditions

Ramapo High School – 16 total split system units currently serve this high school. These units' range in manufacturer with Airedale, Mitsubishi and Daiken all represented. These units range from 1.5 to 6 tons with a total of 43.5 tons of cooling. The two condensing units which serve indoor air handling units are 10 and 30 tons apiece. Within this measure, DCO Energy is evaluating 8 split system units and 2 condensing units for replacement, approxemently 66 tons of cooling. These units were identified to be in poor condition and past ASHREA useful life of 15 years.

Indian Hills High School – 16 total split system units and 2 condensing units currently serve this high school. These rooftop units' range in manufacturer with Daiken, Mitsubishi, Trane and Airedale all represented. The split units range from 3 to 40 tons with a total of 308 tons of cooling. Within this measure, DCO Energy is evaluating 15 units for replacement, approxemently 268 tons of cooling. These units were identified to be in poor condition and past ASHREA useful life of 15 years.



Existing split system AC units at Ramapo HS and Indian Hills HS

Scope of Work

The following Split Systems will be replaced with high efficiency units:

Split System Replacement Scope of Work				
BUILDING	CATEGORY	AREA SERVED	Tons	QUANTITY
Ramapo High School	SSAC-2	Gym Office	1.00	1
	SSAC-5	205	1.00	1
	SSAC-6	217A	2.00	1
	SSAC-15	409	3.00	1
Indian Hills High School	SSAC-974	974	2	1
	CACCU-01	006	2	1
	CACCU-02	059A	2	1
	AHUCU-02	408B	2.5	1
	ACCU01	505	5	1
	ACCU02	505	5	1
	ACCU03	521	5	1
	AHUCU01	621	2.5	1
	CU-1	Auditorium	30	1
	CU-2	Stage	10	1

Ramapo High School and Indian Hills High School

- Take pre-construction air balancing readings on the units to be replaced (Totals Only)
- Lockout/Tag out the electrical power going to existing equipment to be replaced
- Disconnect the electrical power and control wiring and safe off for reuse
- Recover the refrigerant from the existing equipment and dispose of it per the EPA regulations
- Remove all the blowers and discard off site
- Using a crane, remove the existing condensing units from the roof and discard off site
- Using a crane, set the new condensing units onto the existing equipment supports
- Connect the existing electrical power wiring to the new condensing units that were replaced
- Furnish and install new unit thermostat to replace existing
- Furnish and install new refrigerant piping, pressure test and evacuate
- Provide factory startup of the new split systems
- Provide final air balancing and adjust to match pre-construction readings (Totals Only)
- Provide training on the equipment for all the owner's authorized employees

ECM Calculations

Energy Savings from the installation of high efficiency Split Systems were calculated using BPU protocols. The calculations are shown below.

CALCULATED SAVINGS

Split System Replacement - Cooling Savings

BUILDING	SYSTEM	Areas Served	Existing Qty	Tons Per Unit	Total Existing Tons	EERb
Ramapo High School	SSAC-2	Gym Office	1	1.00	1.00	8.4
	SSAC-5	205	1	1.00	1.00	8.4
	SSAC-6	217A	1	2.00	2.00	8.4
	SSAC-15	409	1	3.00	3.00	8.4
	0	0				
Indian Hills High School	SSAC-974	974	1	2	2.00	8.4
	CACCU-01	006	1	2	2.00	8.4
	CACCU-02	059A	1	2	2.00	8.4
	AHUCU-02	408B	1	2.5	2.50	8.4
	ACCU01	505	1	5	5.00	8.4
	ACCU02	505	1	5	5.00	8.4
	ACCU03	521	1	5	5.00	8.4
	AHUCU01	621	1	2.5	2.50	8.4
	CU-1	Auditorium	1	30	30.00	9.8
	CU-2	Stage	1	10	10.00	9.6

Split System Replacement - Cooling Savings

BUILDING	SYSTEM	Proposed Qty	Tons Per Unit	Total Proposed Tons	EERq	CF	EFLH Cooling	Demand Savings (kW)	Energy Savings (kWh)
Ramapo High School	SSAC-2	1	1.0	1.0	13.2	0.5	466	0	240
	SSAC-5	1	1.0	1.0	13.2	0.5	466	0	240
	SSAC-6	1	2.0	2.0	13.3	0.5	466	1	487
	SSAC-15	1	3.0	3.0	13.5	0.5	466	1	750
	0								
Indian Hills High School	N/A	1	2.0	2.0	13.3	0.5	466	1	487
	CACCU-01	1	2.0	2.0	13.3	0.5	466	1	487
	CACCU-02	1	2.0	2.0	13.3	0.5	466	1	487
	AHUCU-02	1	2.5	2.5	13.3	0.5	466	1	609
	ACCU01	1	5.0	5.0	12.8	0.5	466	1	1,136
	ACCU02	1	5.0	5.0	12.8	0.5	466	1	1,136
	ACCU03	1	5.0	5.0	12.8	0.5	466	1	1,136
	AHUCU01	1	2.5	2.5	13.3	0.5	466	1	609
	CU-1	1	30.0	30.0	11.6	0.5	466	3	2,691
	CU-2	1	10.0	10.0	11.9	0.5	466	1	1,120

Split System Replacement - Total Savings						
BUILDING NAME	SYSTEM	Areas Served	Annual Electric Savings	Total Electric Savings	Annual Demand Savings	Total Demand Savings
Ramapo High School	SSAC-2	Gym Office	240	1,717	0	2
Ramapo High School	SSAC-5	205	240		0	
Ramapo High School	SSAC-6	217A	487		1	
Ramapo High School	SSAC-15	409	749		1	
Ramapo High School	0	0	-		-	
Indian Hills High School	SSAC-974	974	487	9,903	1	11
Indian Hills High School	CACCU-01	006	487		1	
Indian Hills High School	CACCU-02	059A	487		1	
Indian Hills High School	AHUCU-02	408B	609		1	
Indian Hills High School	ACCU01	505	1,136		1	
Indian Hills High School	ACCU02	505	1,136		1	
Indian Hills High School	ACCU03	521	1,136		1	
Indian Hills High School	AHUCU01	621	609		1	
Indian Hills High School	CU-1	Auditorium	2,695		3	
Indian Hills High School	CU-2	Stage	1,123		1	

<u>Algorithms</u>

Air Conditioning Algorithms:

Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * ($1/EER_b - 1/EER_q$) * $EFLH_c$

Peak Demand Savings (kW) = N * Tons * 12 kBtuh/Ton * ($1/EER_b - 1/EER_q$) * CF

<u>Definition of Variables</u>

N = Number of units

Tons = Rated cooling capacity of unit.This value comes from ARI/AHRI or AHAM rating or manufacturer data.

EER_b = Energy Efficiency Ratio of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER should be used in place of EER.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

EER_q = Energy Efficiency Ratio of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 (5.4 tons) BtuH, SEER should be used in place of EER.

COP_q = Coefficient of Performance of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value is based on existing measured usage and determined as the average number of operating hours during the peak window period.

$EFLH_{c\ or\ h}$ = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off-peak periods.

<u>Summary of Inputs</u>

HVAC and Heat Pumps

Component	Type	Value	Source
Tons	Variable	Rated Capacity, Tons	Application
EER_b	Variable	See Table below	1
EER_q	Variable	ARI/AHRI or AHAM Values	Application
CF	Fixed	50%	2
$EFLH_{(c\ or\ h)}$	Variable	See Tables below	3

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2016
Water Source Heat Pumps (water to air, water loop) <=1.4 tons >1.4 to 5.4 tons >5.4 to 11.25 tons	 12.2 EER, 4.3 heating COP 13.0 EER, 4.3 heating COP 13.0 EER, 4.3 heating COP
Ground Water Source Heat Pumps <=11.25 tons	18.0 EER, 3.7 heating COP
Ground Source Heat Pumps (brine to air, ground loop) <=11.25 tons	14.1 EER, 3.2 heating COP
Package Terminal Air Conditioners[37]	14.0 – (0.300 * Cap/1,000), EER
Package Terminal Heat Pumps	14.0 – (0.300 * Cap/1,000), EER 3.7 – (0.052 * Cap/1,000), heating COP
Single Package Vertical Air Conditioners <=5.4 tons >5.4 to 11.25 tons >11.25 to 20 tons	 10.0 EER 10.0 EER 10.0 EER
Single Package Vertical Heat Pumps <=5.4 tons >5.4 to 11.25 tons >11.25 to 20 tons	 10.0 EER, 3.0 heating COP 10.0 EER, 3.0 heating COP 10.0 EER, 3.0 heating COP

HVAC Baseline Efficiencies Table – New Construction/EUL/RoF

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2016
Unitary HVAC/Split Systems and Single Package, Air Cooled <=5.4 tons, split <=5.4 tons, single >5.4 to 11.25 tons >11.25 to 20 tons > 21 to 63 tons >63 Tons	 14 SEER 14 SEER 11.0 EER, 12.7 IEER 10.8 EER, 12.2 IEER 9.8 EER, 11.4 IEER 9.5 EER, 11.0 IEER
Air Cooled Heat Pump Systems, Split System and Single Package <=5.4 tons, split <=5.4 tons, single >5.4 to 11.25 tons >11.25 to 20 tons >= 21	 14 SEER, 8.2 HSPF 14 SEER, 8.0 HSPF 10.8 EER, 12 IEER, 3.3 heating COP 10.4 EER, 11.4 IEER, 3.2 heating COP 9.3 EER, 10.4 IEER, 3.2 heating COP

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

ECM 9 – High Efficiency Transformers

RAMAPO INDIAN HILLS RHSD

✓	ECM evaluated but not included
✓ (green)	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
9	High Efficiency Transformers	✓	✓

The primary goal of this ECM is increased energy savings through replacement of old, inefficient transformers with new, ultra-high efficiency transformers. While facilities are unique, electrical infrastructure is almost always based on U.S. industry standard transformers. Transformers are typically purchased as part of a total electrical distribution package, installed, and forgotten for 40-50 years. Most of these transformers are operating at a small fraction of their nameplate capacity, resulting in very low efficiency, and are producing large amounts of excess heat, resulting in energy losses and higher utility costs.

High-efficiency Transformer

Existing Conditions

Existing Transformers at Ramapo HS and Indian Hills HS

Scope of Work

Existing transformers within the facilities will be replaced with high efficiency harmonic mitigating transformers. Harmonic Mitigating Transformers will contribute additional benefits including:

- Reduced power costs
- Reduced penalty losses due to harmonic currents
- Reduced transformer heating and A/C loading
- Reduced THDv to less than 5% at nonlinear loads or motor drives
- Reduced losses in the loads, thereby reducing A/C requirements
- Improved switch-mode power supply's "ride-through" capability
- Balanced primary phase currents
- Assured system compatibility with sensitive electronic loads

High Efficiency Transformer Scope of Work			
BUILDING	TRANSFORMER ID	KVA	QUANTITY
Ramapo High School	RHS-6-8	75	3
	RHS-9	112.5	1
	RHS-10	150.0	1
	RHS-11	225	1
Indian Hills High School	IHHS-20-21	50	2
	IHHS-22-23	75	2
	IHHS-24-25	112.5	2
	IHHS-26	120	1
	IHHS-27-29	150	3
	IHHS-30	225	1

ECM Calculations

Typically, transformers are rated at 30% loading. The savings were calculated using 21.4% at RHS and 9.7% at IHHS. Estimated baseline efficiency was assumed to be 3% less than NEMA TP1 2002 rating at low load conditions.

CALCULATED SAVINGS

High Efficiency Transformer Savings

BUILDING	REPLACEMENT QUANTITY	TRANSFORMER ID	POWER RATING (kVA)	EXISTING EFFICIENCY (Eff baseline)	PROPOSED EFFICIENCY (Eff ee)	LOAD FACTOR (LF)	POWER FACTOR (PF)	ANNUAL OPERATING HOURS (hrs)
Ramapo High School	3	RHS-6-8	75.0	95.00%	98.60%	21.4%	1.0	8,760
Ramapo High School	1	RHS-9	112.5	95.20%	98.74%	21.4%	1.0	8,760
Ramapo High School	1	RHS-10	150.0	95.30%	98.83%	21.4%	1.0	8,760
Ramapo High School	1	RHS-11	225.0	95.50%	98.94%	21.4%	1.0	8,760
Indian Hills High School	2	IHHS-20-21	50.0	94.75%	97.75%	9.7%	1.0	8,760
Indian Hills High School	2	IHHS-22-23	75.0	95.00%	98.60%	9.7%	1.0	8,760
Indian Hills High School	2	IHHS-24-25	112.5	95.20%	98.74%	9.7%	1.0	8,760
Indian Hills High School	1	IHHS-26	120.0	95.25%	98.25%	9.7%	1.0	8,760
Indian Hills High School	3	IHHS-27-29	150.0	95.30%	98.83%	9.7%	1.0	8,760
Indian Hills High School	1	IHHS-30	225.0	95.50%	98.94%	9.7%	1.0	8,760

High Efficiency Transformer Savings

BUILDING	REPLACEMENT QUANTITY	TRANSFORMER ID	POWER RATING (kVA)	COINCIDENCE FACTOR (CF)	ENERGY SAVINGS FACTOR (ESF)	ANNUAL ELECTRIC ENERGY SAVINGS (kWh)	SUMMER PEAK COINCIDENT DEMAND SAVINGS (kW)	ANNUAL ELECTRIC ENERGY SAVINGS (kWh)	SUMMER PEAK COINCIDENT DEMAND SAVINGS (kW)
Ramapo High School	3	RHS-6-8	75.0	1.0	0.79	16,221	1.5	50,079	4.5
Ramapo High School	1	RHS-9	112.5	1.0	0.79	7,947	0.7		
Ramapo High School	1	RHS-10	150.0	1.0	0.79	10,546	0.9		
Ramapo High School	1	RHS-11	225.0	1.0	0.79	15,366	1.4		
Indian Hills High School	2	IHHS-20-21	50.0	1.0	0.76	2,753	0.2	39,418	3.4
Indian Hills High School	2	IHHS-22-23	75.0	1.0	0.76	4,899	0.4		
Indian Hills High School	2	IHHS-24-25	112.5	1.0	0.76	7,201	0.6		
Indian Hills High School	1	IHHS-26	120.0	1.0	0.76	3,269	0.3		
Indian Hills High School	3	IHHS-27-29	150.0	1.0	0.76	14,333	1.2		
Indian Hills High School	1	IHHS-30	225.0	1.0	0.76	6,962	0.6		

High Efficiency Transformer Savings

BUILDING	REPLACEMENT QUANTITY	TRANSFORMER ID	POWER RATING (kVA)	TRANSFORMER OUTPUT (kWh)	BASELINE ELECTRIC (kWh)	POST ESIP ELECTRIC (kWh)	POST ESIP ELECTRIC - REPLACEMENT TRANSFORMERS (kWh)	POST ESIP TRANSFORMER % of Building Load
Ramapo High School	3	RHS-6-8	75.0	1,336,504	2,232,867	1,617,873	1,336,504	83%
Ramapo High School	1	RHS-9	112.5					
Ramapo High School	1	RHS-10	150.0					
Ramapo High School	1	RHS-11	225.0					
Indian Hills High School	2	IHHS-20-21	50.0	1,079,320	2,102,051	1,502,549	1,079,320	72%
Indian Hills High School	2	IHHS-22-23	75.0					
Indian Hills High School	2	IHHS-24-25	112.5					
Indian Hills High School	1	IHHS-26	120.0					
Indian Hills High School	3	IHHS-27-29	150.0					
Indian Hills High School	1	IHHS-30	225.0					

Measure Description

This measure covers the installation of new electric transformers (i.e. not refurbished equipment) exceeding codes and standards required efficiency in commercial and industrial applications. These transformers are used to step down power from distribution voltage to serve HVAC, process and plug loads in commercial and industrial facilities.

This measure is only applicable to low-voltage dry-type distribution transformers, liquid-immersed distribution transformers, and medium-voltage dry-type distribution transformers installed behind the meter, for which minimum federal efficiency standards are defined.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = kVA \times \left(\frac{1}{Eff_{baseline}} - \frac{1}{Eff_{ee}}\right) \times LF \times PF \times hrs$$

Summer Peak Coincident Demand Savings

$$\Delta kW = kVA \times \left(\frac{1}{Eff_{baseline}} - \frac{1}{Eff_{ee}}\right) \times LF \times PF \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = N/A$$

where:

ΔkWh = Annual electricity energy savings
ΔkW = Peak coincident demand electric savings
ΔMMBtu = Annual fossil fuel energy savings
kVA = Power rating of the transformer, in kVA
$_{baseline}$ = Characteristic of baseline condition
$_{ee}$ = Characteristic of energy efficient condition
Eff = Efficiency rating of transformer (must be entered as a decimal value)
PF = Power Factor, ratio of real power to apparent power supplied to the transformer
LF = Load Factor, ratio of average annual transformer load to peak load rating
hrs = Annual operating hours
CF = Coincidence factor

Summary of Variables and Data Sources

Variable	Value	Notes
kVA		From application.
$Eff_{baseline}$		Lookup based on transformer type, phase and kVA rating in Baseline Efficiency section below.

Variable	Value	Notes
Eff_{ee}		From application.
LF		From application. Can be approximated as total annual facility kWh consumption divided by the product of transformer kVA rating and 8,760.
PF		From application. If unavailable, use 1.0 as default.[1288]
hrs		From application. If unknown, use 8,760.
CF	1.0	

Coincidence Factor (CF)

The prescribed value for the coincidence factor is 1.0.[1289]

ECM 15 – Combined Heat & Power

RAMAPO INDIAN HILLS RHSD

✓	ECM evaluated but not included
✓	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
15	Combined Heat & Power Unit		✓

CHP offers energy and environmental benefits over electric-only and thermal-only systems in both central and distributed power generation applications. CHP systems have the potential for a wide range of applications and the higher efficiencies result in lower emissions than separate heat and power generation.

35kW Yanmar CHP

The simultaneous production of useful thermal and electrical energy in CHP systems lead to increased fuel efficiency. CHP units can be strategically located at the point of energy use. Such onsite generation avoids the transmission and distribution losses associated with electricity purchased via the grid from central stations. CHP is versatile and can be coupled with existing and planned technologies for many different applications in the industrial, commercial, and residential sectors.

Scope of Work

- Provide engineered and stamped drawings including shop drawings, submittals and as-builts.
- File for City Permits
- Apply for the Interconnection application
- Furnish and install new equipment housekeeping pad for the CHP outside by the generator
- Furnish new 35 KW CHP and secure on the new pad
- Furnish and Install new thermal load module to interface with buildings space heating
- Furnish and install all piping for the CHP, load module, tie in to heating loop, and make up water piping
- Furnish and install gas piping to the new CHP
- Insulate all newly installed piping
- Furnish and install all electrical power and control wiring
- Furnish and install exhaust for the CHP (To the roof)
- Provide startup of the CHP
- Provide certified balancing report

The following will be installed at Indian Hills High School:

- One (1) CP35D1-TNUW Non-Black Start Capable, Including:
  - 35kW, 208 V, 60 Hz, 3-Phase, 3W
  - Industrial Natural Gas Engine, EPA Certified
  - Acoustical Enclosure
  - Engine Jacket, Oil, and Exhaust Heat Recovery
  - Yanmar Microprocessor Controls
  - Open Protocol Interface (Modbus-based or BACnet) with Controller only
  - Emissions Control Package
  - Standard Electrical Protective Switchgear Panel
  - Critical Grade Silencer
  - Complete Factory Assembly
  - Factory Full-Load Test Run
  - CLCW2B1 - Yanmar RMA (Remote Monitoring Adaptor)
  - ACDC24 - Yanmar Power Cord
  - HKC35D - Yanmar heater kit, required for outdoor install

- Thermal Load Module to interface with building’s space heating system:
  - BTU Meter

- Circulation Pump
- Control Valve
- Gauges/Temp Sensors
- Isolation Valves
- Pre-wired for Aegis Propriety Remote Monitoring & Control

- Proprietary Aegis Remote Monitoring & Control (Building Automation System) Package:
  - Microprocessor based DDC Control System
  - Low Voltage Controls and Internal Panel Wiring
  - Motor starters & circuit protection for on-board pumps, motors, and fans
  - Low voltage and high voltage internal panel wiring
  - Allows for data communication for live “Real Time” monitoring
  - Controls operation of entire CHP system
  - Allows for remote restart (rather than manual) of system
  - Allows for remote resolution of system alarms
  - Allows for real-time monitoring and adjustments
  - Provides an on-board computer for data collection and instant accessibility

- Metering Package for Data Verification:
  - Gas meter with pulse output
  - Power transducer for CHP power monitoring
  - Btu Meter
  - Data acquisition panel

- Beckwith
  - Utility grade protection relay
  - 32R Protection
  - Includes three (3) CT’s

ECM Calculations

The CHP will act as the first stage of heating for the hot water heating loop. The CHP is estimated to run at full load for over 3,266 hours per year. Run hours were estimated using eQuest simulations where a 35 kW CHP was proposed at a similar building. eQuest conservatively estimates run hours because it accounts for heating and electric loads on an hourly basis, which limits the run hours. There are certain hours during colder months where the CHP will not meet the entire heating load. eQuest accounts for this and requires the boilers to fire to meet the remaining load. Non-displaceable gas use is estimated to be 27% (kitchen appliances, gas-fired RTUs, etc.) during the heating season. The remaining load is available for the CHP. For a more conservative energy savings calculation, the CHP is allowed to run during the heating season only (October through May). The installed CHP will be available year-round and will operate when adequate heating load exists. If necessary, heat can be rejected through a radiator when the full heating load is not required.

CHP Input Data		
Number of units	1	
Electrical output	35	kW
Thermal output	204,040	BTU/hr
Gas input (HHV)	407,144	Btu/hr
Overall efficiency	79.4%	

Runtime Analysis	
Run hours	3,266
Full load heat and electric hours	3,266
% Boiler load displaced by CHP	10%
% Heat dump (if applicable)	0%
Run CHP 24/7 with Heat Dump?	N

		Fuel Usage Without CHP					
Month	Days	Total Gas - Post ECMs (Baseline reduced by 30%)	Proposed Boiler Efficiency	Non-Displaceable Gas Therms, Boilers OFF June-Oct	Displaceable Gas Therms	Displaceable Heat Therms
Jan	31	14,617	84.9%	3,945	10,672	9,061
Feb	28	17,197	84.9%	4,641	12,556	10,660
Mar	31	17,194	84.9%	4,640	12,554	10,658
Apr	30	11,579	84.9%	3,125	8,455	7,178
May	31	5,704	84.9%	1,539	4,164	3,536
Jun	30	2,505	84.9%	2,505	0	0
Jul	31	485	84.9%	485	0	0
Aug	31	41	84.9%	41	0	0
Sep	30	16	84.9%	16	0	0
Oct	31	626	84.9%	169	457	388
Nov	30	3,835	84.9%	1,035	2,800	2,377
Dec	31	9,900	84.9%	2,672	7,229	6,137
Total:	365	83,700		24,812	58,887	49,995

		35 kW Cogen Plant Thermal Operation									
Month	Days	Combined Cogen Run Hours	% Heat Load Displaced by CHP	Cogen Dump Hours	Total Cogen Hours	Utilized Cogen Heat Therms	Dumped Cogen Heat Therms	Max Cogen Heat Therms	Avoided Boiler Gas Therms	Full Load Run Hours	System Operating Efficiency
Jan	31	618	11%	0	618	993	0	1,261	1,169	618	69%
Feb	28	564	8%	0	564	889	0	1,150	1,048	564	68%
Mar	31	559	8%	0	559	832	0	1,141	980	559	66%
Apr	30	345	6%	0	345	441	0	703	520	345	61%
May	31	118	4%	0	118	151	0	241	178	118	61%
Jun	30	0	0%	0	0	0	0	0	0	0	-
Jul	31	0	0%	0	0	0	0	0	0	0	-
Aug	31	0	0%	0	0	0	0	0	0	0	-
Sep	30	0	0%	0	0	0	0	0	0	0	-
Oct	31	78	30%	0	78	117	0	159	137	78	66%
Nov	30	368	23%	0	368	551	0	750	649	368	66%
Dec	31	617	15%	0	617	946	0	1,259	1,114	617	67%
Total:	365	3,266	9.8%	0	3,266	4,921	0	6,664	5,796	3,266	66%

		Fuel Usage With CHP			Electric Savings With CHP			
Month	Days	Supplemental Boiler Gas Therms	Cogen Gas Therms	Total Gas	Run Hours	Avg Cogen Plant kW Output	kW Demand Savings	Cogen Electric Generation kWh
Jan	31	9,503	2,517	15,964	618	35	35	21,634
Feb	28	11,509	2,294	18,444	564	35	35	19,724
Mar	31	11,574	2,276	18,490	559	35	35	19,565
Apr	30	7,935	1,403	12,462	345	35	35	12,058
May	31	3,986	482	6,007	118	35	35	4,141
Jun	30	0	0	2,505	0	0	0	0
Jul	31	0	0	485	0	0	0	0
Aug	31	0	0	41	0	0	0	0
Sep	30	0	0	16	0	0	0	0
Oct	31	320	316	805	78	35	35	2,720
Nov	30	2,151	1,497	4,682	368	35	35	12,868
Dec	31	6,114	2,513	11,299	617	35	35	21,599
Total:	365	53,091	13,297	91,200	3,266		35	114,307

The NJ Protocol is to follow the National Renewable Energy Laboratory's Combined Heat and Power, The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures [1]. The product should be all of the below outputs, as applicable:

a. Annual energy input to the generator, HHV basis (MMBtu/yr)
b. Annual electricity generated, net of all parasitic loads (kWh/yr)
c. Annual fossil fuel energy savings from heat recovery (MMBtu/yr)
d. Annual electric energy savings from heat recovery, including absorption chiller sourced savings if chiller installation is included as part of the system installation (kWh/yr)
e. Annual overall CHP fuel conversion efficiency, HHV basis (%)
f. Annual electric conversion efficiency, net of parasitics, HHV basis (%)

CHP Emissions Reduction Associated with PJM Grid
(Assuming that the useful thermal output will displace natural gas)

Algorithms

CO_2 ER (lbs) = (CO_2 EF_{elec} – CO_2 EF_{CHP}) * Net Electricity Generation (MWh) + CO_2 EF_{elec} * Electric Energy Savings (MWh) + CO_2 EF_{NG} * Gas Energy Savings (MMBtu) * 10

NO_x ER (tons) = (NO_x EF_{elec} – NO_x EF_{CHP}) * Net Electricity Generation (MWh) + NO_x EF_{elec} * Electric Energy Savings (MWh) + NO_x EF_{NG} * Gas Energy Savings (MMBtu) * 10

SO_2 ER (lbs) = (SO_2 EF_{elec} – SO_2 EF_{CHP}) * Net Electricity Generation (MWh) + SO_2 EF_{elec} * Electric Energy Savings (MWh)
Hg (grams) = (Electric Energy Savings (MWh) * Hg EF_{elec})/1,000

Definition of Variables

CO_2 EF_{elec} = CO_2 Electric Emissions Factor – see emissions tables summarized in Introduction section of Protocols

NO_x EF_{elec} = NO_x Electric Emissions Factor – see emissions tables summarized in Introduction section of Protocols

SO_2 EF_{elec} = SO_2 Electric Emissions Factor – see emissions tables summarized in Introduction section of Protocols

Hg EF_{elec} = Hg Electric Emissions Factor – see emissions tables summarized in Introduction section of Protocols

CO_2 EF_{CHP} = CO_2 Emissions Factor of the CHP system (in lbs/MWh), which will vary with different projects based on the types of prime movers and emission control devices used

NO_x EF_{CHP} = NO_x Emissions Factor of the CHP system (in lbs/MWh), which will vary with different projects based on the types of prime movers and emission control devices used

SO_2 EF_{CHP} = SO_2 Emissions Factor of the CHP system (in lbs/MWh), which will vary with different projects based on the types of prime movers and emission control devices used

CO_2 EF_{NG} = CO_2 Natural Gas Emissions Factor associated with boiler fuel displacement – see emissions tables summarized in Introduction section of Protocols

NO_x EF_{NG} = NO_x Natural Gas Emissions Factor associated with boiler fuel displacement – see emissions tables summarized in Introduction section of Protocols

10 = Conversion from MMBtu to therms (1 MMBtu = 10 therms)

Calculation of Clean Air Impacts

The amount of air emission reductions resulting from the energy savings is calculated using the energy savings at the system level and multiplying them by factors provided by the New Jersey Department of Environmental Protection, Office of Air and Energy Advisor, on June 25, 2019.

Using Weighted Average of 2018 PJM On-Peak and Off-Peak annual data:

Electric Emission Factors

Emissions Product	Pounds per MWh[7]
CO_2	1,292
NOx	0.83
SO_2	0.67
Hg	1.1 mg/MWh[8]

Natural Gas Emission Factors

Emissions Product	Current
CO_2	11.7 lbs per therm saved
NOx	0.0092 lbs per therm saved

CALCULATED SAVINGS

Combined Heat & Power Emission Reduction

BUILDING	SQFT	kW	Equivalent Full Load Electric Hours	NET GENERATION MWh	FUEL INPUT MMBTU	ELECTRIC SAVINGS FROM HEAT RECOVERY MWh	FOSSIL FUEL SAVINGS FROM HEAT RECOVERY MMBTU	CO2 EF ELECTRIC	CO2 EF CHP
Ramapo High School	241,600	35	3,266	114.3	1,329.7	0	579.6	1,292.0	1,361.0

Combined Heat & Power Emission Reduction

BUILDING	CO2 EF GAS	CO2 EMISSION REDUCTION LBS	NOx EF ELECTRIC	NOx EF CHP	NOx EF GAS	NOx EMISSION REDUCTION LBS	SO2 EF ELECTRIC	SO2 EF CHP	SO2 EMISSION REDUCTION LBS
Ramapo High School	117.0	59,924.2	0.83	1.07	0.092	25.9	0.67	0.00	76.6

Combined Heat & Power Emission Reduction											
BUILDING	Hg EF ELECTRIC	Hg EMISSION REDUCTION LBS	CHP Gas Input (therms)	Post ECM Boiler/DWH Gas Use (therms)	Post CHP Boiler/DWH Gas Use (therms)	Boiler/DWH Gas Savings (therms)	Net Building Gas Savings (therms)	Boiler/DWH Efficiency	CHP Heat Recovered (MMBTU)	CHP Overall Efficiency
Ramapo High School	0.67	0.0	13,297	58,887	53,091	5,796	-7,501	85%	493	37%

Note: CHP emission factors for CO2 and NOx were calculated using nameplate electric generation and natural gas input capacity as seen in the ECM calculation. Per BPU Protocols, natural gas does not require SO2 or Hg emission factors.

The NJ Protocol is to follow the National Renewable Energy Laboratory's Combined Heat and Power, The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures [1]. The product should be all of the below outputs, as applicable:

a. Annual energy input to the generator, HHV basis (MMBtu/yr)
b. Annual electricity generated, net of all parasitic loads (kWh/yr)
c. Annual fossil fuel energy savings from heat recovery (MMBtu/yr)
d. Annual electric energy savings from heat recovery, including absorption chiller sourced savings if chiller installation is included as part of the system installation (kWh/yr)
e. Annual overall CHP fuel conversion efficiency, HHV basis (%)
f. Annual electric conversion efficiency, net of parasitics, HHV basis (%)

SO_2 ER (lbs) = (SO_2 EF_{elec} – SO_2 EF_{CHP}) * Net Electricity Generation (MWh) + SO_2 EF_{elec} * Electric Energy Savings (MWh)

Hg (grams) = (Electric Energy Savings (MWh) * Hg EF_{elec})/1,000

Definition of Variables

CO_2 EF_{elec} = CO_2 Electric Emissions Factor – see emissions tables summarized in Introduction section of Protocols

NO_x EF_{elec} = NO_x Electric Emissions Factor – see emissions tables summarized in Introduction section of Protocols

SO_2 EF_{elec} = SO_2 Electric Emissions Factor – see emissions tables summarized in Introduction section of Protocols

Hg EF_{elec} = Hg Electric Emissions Factor – see emissions tables summarized in Introduction section of Protocols

CO_2 EF_{CHP} = CO_2 Emissions Factor of the CHP system (in lbs/MWh), which will vary with different projects based on the types of prime movers and emission control devices used

NO_x EF_{CHP} = NO_x Emissions Factor of the CHP system (in lbs/MWh), which will vary with different projects based on the types of prime movers and emission control devices used

SO_2 EF_{CHP} = SO_2 Emissions Factor of the CHP system (in lbs/MWh), which will vary with different projects based on the types of prime movers and emission control devices used

CO_2 EF_{NG} = CO_2 Natural Gas Emissions Factor associated with boiler fuel displacement – see emissions tables summarized in Introduction section of Protocols

NO_x EF_{NG} = NO_x Natural Gas Emissions Factor associated with boiler fuel displacement – see emissions tables summarized in Introduction section of Protocols

10 = Conversion from MMBtu to therms (1 MMBtu = 10 therms)

Calculation of Clean Air Impacts

The amount of air emission reductions resulting from the energy savings is calculated using the energy savings at the system level and multiplying them by factors provided by the New Jersey Department of Environmental Protection, Office of Air and Energy Advisor, on June 25, 2019.

Using Weighted Average of 2018 PJM On-Peak and Off-Peak annual data:

Electric Emission Factors

Emissions Product	Pounds per MWh[7]
CO_2	1,292
NOx	0.83
SO_2	0.67
Hg	1.1 mg/MWh[8]

Natural Gas Emission Factors

Emissions Product	Current
CO_2	11.7 lbs per therm saved
NOx	0.0092 lbs per therm saved

CHP Emissions Reduction Associated with PJM Grid

(Assuming that the useful thermal output will displace natural gas)

Algorithms

CO_2 ER (lbs) = (CO_2 EF_{elec} – CO_2 EF_{CHP}) * Net Electricity Generation (MWh) + CO_2 EF_{elec} * Electric Energy Savings (MWh) + CO_2 EF_{NG} * Gas Energy Savings (MMBtu) * 10

NO_x ER (tons) = (NO_x EF_{elec} – NO_x EF_{CHP}) * Net Electricity Generation (MWh) + NO_x EF_{elec} * Electric Energy Savings (MWh) + NO_x EF_{NG} * Gas Energy Savings (MMBtu) * 10

New Jersey's Clean Energy Program
Protocols to Measure Resource Savings
Page 116

ECM 17 – Unit Ventilator Replacement

RAMAPO INDIAN HILLS RHSD

✓	ECM evaluated but not included
✓ (green)	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
17	Unit Ventilator Replacement	✓	✓

New unit ventilators will improve classroom indoor air quality. Superior indoor air quality can help ensure a healthier and higher performance learning environment for students and staff, and the choice of ventilation equipment plays a big role in the quality of the indoor air. Proper ventilation with outdoor air is a key component for good indoor air quality in schools and classrooms since indoor air may be two to five times more polluted than outdoor air, and there are large populations of children who may be more susceptible to indoor pollutants than the general population.

Unit Ventilator

The high occupant densities of schools and classrooms often make it challenging for building designers to incorporate ventilation systems that provide adequate outdoor ventilation air (in compliance with the industry's ventilation standard, ASHRAE 62-2022), while providing buildings with good indoor air quality and minimized costs.

Existing Conditions


Existing unit ventilators at Indian Hills HS and Ramapo HS

Scope of Work

- Coordinate installation time and duration to ensure operations are unaffected
- Remove and properly dispose of existing unit ventilators
- Ensure wall penetration for outdoor air intake is large enough for ventilation compliant with code (may require masonry work to accommodate larger louver)
- Install new unit ventilators with new hot water modulating valves, hot water coils and D/X cooling coils (118 total; 57 at RHS and 61 at IHHS)
- DDC controllers per manufacturer's specifications included in Energy Management System upgrades scope of work by EMS contractor and field mounted by mechanical contractor
- Installation test and functional check

Ramapo High School –

- Removal of approximately fifty-seven (57) heating only, hot water classroom unit ventilators.
- Furnish and install fifty-seven (57) new classroom unit ventilators with hot water heating and D/X cooling coils. New unit ventilators shall be provided with manufacturer's standard controls capable of being integrated into the Building Automation System via BACnet communication.
- Electrical disconnects and reconnects. Existing disconnect to be reused
- UV sizing/capacities shall be based on existing unit ventilator schedules and ASHRAE 90.1-2019 and 62.1-2022 requirements.

Indian Hills High School –

- Removal of approximately sixty-one (61) heating only, hot water classroom unit ventilators.
- Furnish and install sixty-one (61) new classroom unit ventilators with hot water heating and D/X cooling coils. New unit ventilators shall be provided with manufacturer's standard controls capable of being integrated into the Building Automation System via BACnet communication.
- Electrical disconnects and reconnects. Existing disconnect to be reused
- UV sizing/capacities shall be based on existing unit ventilator schedules and ASHRAE 90.1-2019 and 62.1-2022 requirements

Unit Ventilator Replacement Scope of Work			
BUILDING	**CATEGORY**	**NOTES**	**QUANTITY**
Ramapo High School	HVAC (vertical UV, wall mounted)	Unit Ventilator	57
		Intergration of new Units into Existing System	1
Indian Hills High School	HVAC (vertical UV, wall mounted)	Unit Ventilator	61
		Intergration of new Units into Existing System	1

ECM Calculations

Energy Savings from the installation of unit ventilators were calculated using BPU protocols. The calculations are shown below.

CALCULATED SAVINGS									
Unit Ventilator Replacement Savings									
BUILDING	**UNIT TAG**	**NUMBER OF UNITS**	**FAN MOTOR HP**	**EXISTING MOTOR EFFICIENCY (Nbase)**	**REPLACEMENT MOTOR EFFICIENCY (Nprem)**	**LF**	**CF**	**IFvfd**	**HRS**
Ramapo High School	UV-0750	1	0.25	85.5%	85.5%	0.75	0.74	1.0	2745
Ramapo High School	UV-1000	42	0.25	85.5%	85.5%	0.75	0.74	1.0	2745
Ramapo High School	UV-1250	10	0.25	85.5%	85.5%	0.75	0.74	1.0	2745
Ramapo High School	UV-1500	4	0.25	85.5%	85.5%	0.75	0.74	1.0	2745
Indian Hills High School	UV-0750	3	0.25	85.5%	85.5%	0.75	0.74	1.0	2745
Indian Hills High School	UV-1000	53	0.25	85.5%	85.5%	0.75	0.74	1.0	2745
Indian Hills High School	UV-1250	3	0.25	85.5%	85.5%	0.75	0.74	1.0	2745
Indian Hills High School	UV-1500	2	0.25	85.5%	85.5%	0.75	0.74	1.0	2745

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

Unit Ventilator Replacement Savings												
BUILDING	UNIT TAG	NUMBER OF UNITS	ΔkW	DEMAND SAVINGS (Kw)	ELECTRIC SAVINGS (kWh)	ECM Motor VFD ESF	ECM Motor VFD DSF	VFD DEMAND SAVINGS (kW)	VFD ELECTRIC SAVINGS (kWh)	TOTAL DEMAND SAVINGS (kW)	TOTAL ELECTRIC SAVINGS (kWh)
Ramapo High School	UV-0750	1	0.00	0.00	0	1,788	0.297	0.1	447	0.1	447
Ramapo High School	UV-1000	42	0.00	0.00	0	1,788	0.297	3.1	18,774	3.1	18,774
Ramapo High School	UV-1250	10	0.00	0.00	0	1,788	0.297	0.7	4,470	0.7	4,470
Ramapo High School	UV-1500	4	0.00	0.00	0	1,788	0.297	0.3	1,788	0.3	1,788
Indian Hills High School	UV-0750	3	0.00	0.00	0	1,788	0.297	0.2	1,341	0.2	1,341
Indian Hills High School	UV-1000	53	0.00	0.00	0	1,788	0.297	3.9	23,691	3.9	23,691
Indian Hills High School	UV-1250	3	0.00	0.00	0	1,788	0.297	0.2	1,341	0.2	1,341
Indian Hills High School	UV-1500	2	0.00	0.00	0	1,788	0.297	0.1	894	0.1	894

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
LF	Fixed	0.75	1
η_{base}	Fixed	ASHRAE 90.1-2016 Baseline Efficiency Table	ASHRAE
η_{prem}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
IF_{VFD}	Fixed	1.0 or 0.9	3
Efficiency - η_{ee}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
CF	Fixed	0.74	1
HRS	Fixed	Annual Operating Hours Table	1

Algorithms

Energy Savings (kWh/yr) = N * HP * ESF

Peak Demand Savings (kW) = N * HP * DSF

Definitions of Variables

N = Number of motors controlled by VFD(s) per application
HP = Nameplate motor horsepower or manufacturer specification sheet per application
ESF = Energy Savings Factor (kWh/year per HP)
DSF = Demand Savings Factor (kW per HP)

Summary of Inputs

Variable Frequency Drives

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
ESF	Variable	See Table Below	Derived value based on the following sources: 1, 2, 3
DSF	Variable	See Table Below	Derived value based on the following sources: 1, 2, 3

The ESF for the supply and return fans and circulating pumps are derived from a 2014 NEEP-funded study of 400 VFD installations in eight northeast states. The derived values are based on actual logged input power data and reflect average operating hours, load factors, and motor efficiencies for the sample. Savings factors representing cooling tower fans and boiler feed water pumps are not reflected in the NEEP report. Values representing these applications are taken from April 2018 New York TRM, Appendix K, and represent average values derived from DOE2.2 simulation of various building types

VFD Savings Factors

Application	ESF (kWh/Year-HP)	DSF (kW/HP)	Source
Supply Air Fan	2,033	0.286	1
Return Air Fan	1,788	0.297	1
CHW or CW Pump	1,633	0.185	1
HHW Pump	1,548	0.096	1
WSHP Pump	2,562	0.234	1
CT Fan	290	-0.025	2, 3
Boiler Feedwater Pump	1,588	0.498	2, 3

1	.825	.825	.855	.855	.77	.77
1.5	.865	.875	.865	.865	.84	.84
2	.875	.885	.865	.865	.855	.855
3	.885	.895	.895	.895	.855	.865
5	.895	.895	.895	.895	.865	.885
7.5	.902	.91	.91	.917	.885	.895
10	.917	.91	.917	.917	.895	.902
15	.917	.917	.93	.924	.902	.91
20	.924	.917	.93	.930	.91	.91
25	.93	.93	.936	.936	.917	.917
30	.936	.93	.941	.936	.917	.917
40	.941	.941	.941	.941	.924	.924
50	.941	.941	.945	.945	.93	.93
60	.945	.945	.95	.950	.936	.936
75	.945	.945	.95	.954	.936	.936
100	.95	.95	.954	.954	.936	.941
125	.95	.95	.954	.954	.941	.95
150	.954	.958	.958	.958	.941	.95
200	.954	.958	.958	.962	.95	.954

Annual Operating Hours Table

Motor Horsepower	Operating Hours, HRS
1 to 5 HP	2,745
6 to 20 HP	3,391
21 to 50 HP	4,067
51 to 100 HP	5,329
101 to 200 HP	5,200

Algorithms

From application form calculate ΔkW where:

$$\Delta kW = 0.746 * HP * IF_{VFD} * (1/\eta_{base} - 1/\eta_{prem})$$

Demand Savings = (ΔkW) * CF

Energy Savings = (ΔkW)*HRS * LF

Definition of Variables
ΔkW = kW Savings at full load
HP = Rated horsepower of qualifying motor, from nameplate/manufacturer specs.
LF = Load Factor, percent of full load at typical operating condition
IF_{VFD} = VFD Interaction Factor, 1.0 without VFD, 0.9 with VFD
η_{base} = Efficiency of the baseline motor
η_{prem} = Efficiency of the energy-efficient motor
HRS = Annual operating hours
CF = Coincidence Factor

ECM 18 – Variable Refrigerant Flow Installation

RAMAPO INDIAN HILLS RHSD

✓	ECM evaluated but not included
✓	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
18	Variable Refrigerant Flow Installation	✓	✓

Variable Refrigerant Flow (VRF) unit

VRF systems are like traditional D/X split systems except that a single VRF heat pump condensing unit serves multiple D/X coils. The VRF condensing unit modulates the compressor and flow of refrigerant based on the exact heating and cooling demand of the connected indoor units. Some additional benefits of VRF systems versus traditional D/X split systems are: Reduced installation costs, reduced operational costs (less electrical consumption), ability to provide simultaneous heating and cooling with a single VRF system, less maintenance costs due to fewer mechanical components (i.e. compressors) and lower outdoor unit sound levels. The system being proposed in this ECM will utilize a standard classroom unit ventilator style indoor unit that will fit in the same area as the existing classroom unit ventilators. Heating will be accomplished utilizing the new VRF heat pumps with secondary electric resistance heating coils. Cooling will be accomplished utilizing direct expansion, or D/X, coils served by remote VRF condensing units. The unit ventilator will also allow for economizer mode of operation, or free cooling, when the outdoor ambient conditions are permit the use of 100% outside air.

Existing Conditions


Existing unit ventilators at Indian Hills HS and Ramapo HS

- 57 Classrooms at Ramapo High School currently do not have cooling and are served by 57 hot-water Unit Ventilators (heating only).
- 60 Classrooms at Indian Hills High School currently do not have cooling and are served by 61 hot-water Unit Ventilators (heating only).

Ramapo Indian Hills Regional High School District has expressed interest to add cooling to these 117 classrooms between both schools (118 Unit Ventilators). DCO Energy has recommended the installation of Variable Refrigerant Flow units which will be equipped to the new proposed unit ventilators in ECM 17. These unit ventilators will be equipped with a D/X coil and will be able to provide cooling to classroom spaces via the VRF system.

Scope of Work

Ramapo High School

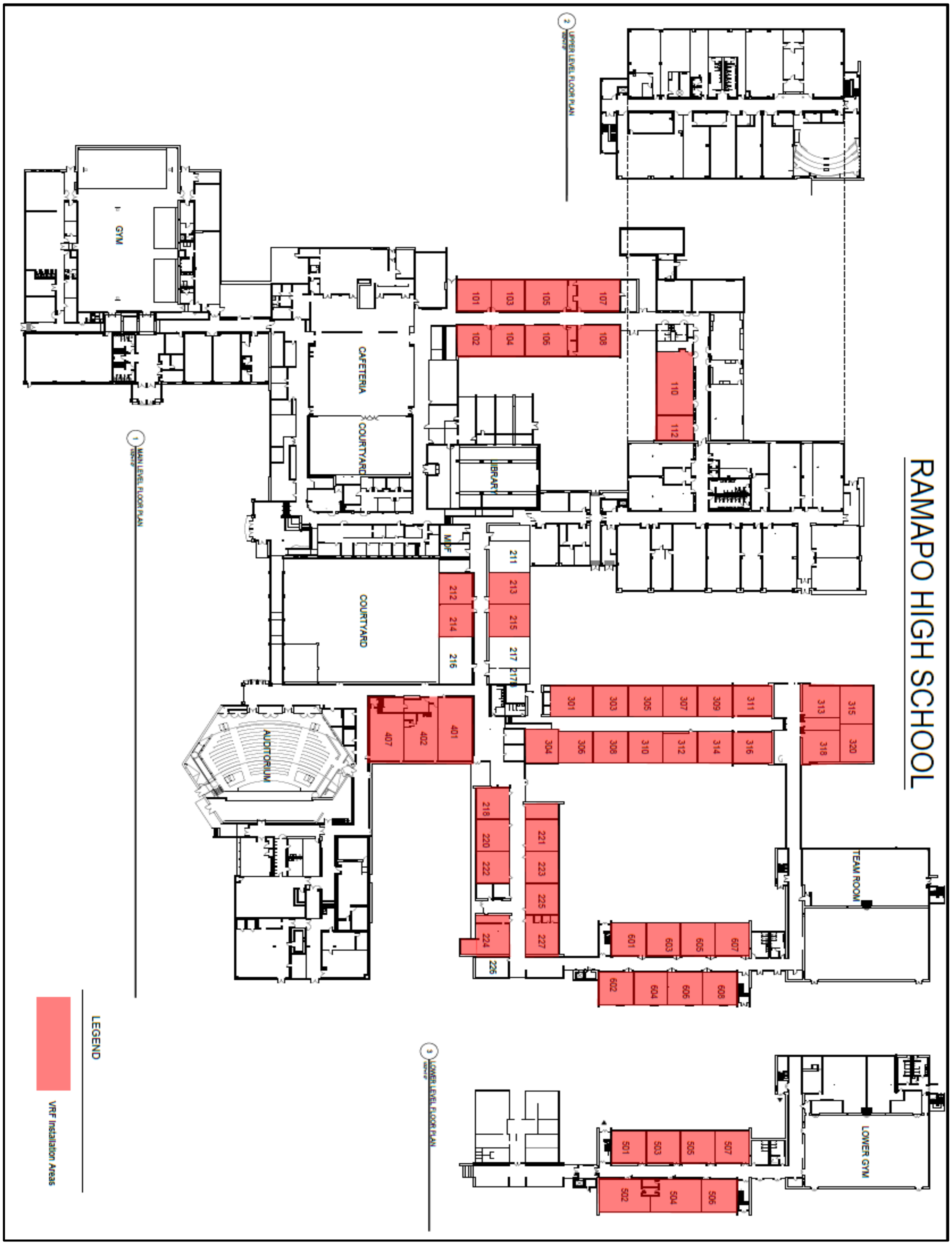
- Furnishing and installation of approximately ten (10) new outdoor variable refrigerant flow (VRF) condensing units, or a total of approximately 228 Tons of cooling capacity. Size, quantity, and approximate location of each outdoor condensing unit shall be based on the attached unit ventilator schedule and scope of work floor plans.
- Provide all required controls and control wiring between the VRF condensing units and associated classroom unit ventilators for a complete and functional system.
- New condensing units shall be mounted on the roof. Provide all roof supports (equipment rails) and roof repairs required to maintain existing roof warranty.

- Furnish and install new refrigerant piping from outdoor condensing unit to new indoor unit ventilators. Refrigerant piping shall be run on the outside of the building, either on the roof or on the exterior wall(s) in a protective pipe enclosure. Refrigerant piping shall be run inside the building as much as possible in pipe covers (horizontal and vertical.
- Electrical
    - Disconnect existing electrical power to classroom UVs being removed and re-use/reconnect to new classroom UVs.
    - Provide new electrical power for outdoor condensing units. Contractor shall assume a new main breaker will be required at the primary electrical service.
    - Provide new electrical distribution, including new electrical subpanels, breakers, conduit, and feeders to serve new outdoor condensing units.

Indian Hills High School

- Furnishing and installation of approximately twelve (12) new outdoor variable refrigerant flow (VRF) condensing units, or a total of approximately 248 Tons cooling capacity. Size, quantity, and approximate location of each outdoor condensing unit shall be based on the attached unit ventilator schedule and scope of work floor plans.
- Provide all required controls and control wiring between the VRF condensing units and associated classroom unit ventilators for a complete and functional system.
- New condensing units shall be mounted on the roof. Provide all roof supports (equipment rails) and roof repairs required to maintain existing roof warranty.
- Furnish and install new refrigerant piping from outdoor condensing unit to new indoor unit ventilators. Refrigerant piping shall be run on the outside of the building, either on the roof or on the exterior wall(s) in a protective pipe enclosure. Refrigerant piping shall be run inside the building as much as possible in pipe covers (horizontal and vertical.)
- Electrical
    - Disconnect existing electrical power to classroom UVs being removed and re-use/reconnect to new classroom UVs.
    - Provide new electrical power for outdoor condensing units. Contractor shall assume a new main breaker will be required at the primary electrical service.
    - Provide new electrical distribution, including new electrical subpanels, breakers, conduit, and feeders to serve new outdoor condensing units.

VRF Installation Scope Of Work					
BUILDING	CATEGORY	AREA SERVED	Tons	QUANTITY	NOTES
Ramapo High School	Variable Refrigerant Flow Unit	CL502, CL504, CL506, CL507, CL505, CL503, CL501	28	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL602, CL604, CL606, CL608, CL601, CL603, CL605, CL207	32	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL227, CL225, CL223, CL221, CL224, CL222, CL220, CL218	32	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL407, CL405, CL401	12	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL304, CL306, CL308, CL310, CL312, CL314, CL316	28	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL318, CL320, CL315, CL313	16	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL311, CL309, CL307, CL305, CL303, CL301	24	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL215, CL213, CL212, CL214	16	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL112, CL110	8	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL108, CL106, CL104, CL102,CL107, CL105, CL103, CL101	32	1	VRF, Refrigerant Piping, Electrical Sub Panels
Indian Hills High School	Condensing Unit	CL 802	4	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL810, CL812, CL814, CL816, CL805	24	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL604, CL606, CL608, CL610, CL612	20	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL617, CL615, CL613, CL611, CL609, CL607, CL601	28	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL407, CL403, CL402, CL401	16	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL202, CL204, CL206, CL208	16	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL702, CL704, CL706, CL708, CL710, CL712, CL714	28	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL703, CL500, CL504, CL508, CL512	20	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL517, CL515, CL513, CL511, CL509, CL507, CL501	28	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL306, CL305, CL304, CL303, CL302, CL301	24	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL102, CL104, CL106, CL108, CL111, CL109, CL105, CL105	32	1	VRF, Refrigerant Piping, Electrical Sub Panels
	Variable Refrigerant Flow Unit	CL097, CL096	8	1	VRF, Refrigerant Piping, Electrical Sub Panels
		Total	**476**	**22**	


RAMAPO HIGH SCHOOL
LEGEND
VRF Installation Areas
UPPER LEVEL FLOOR PLAN
MAIN LEVEL FLOOR PLAN
LOWER LEVEL FLOOR PLAN
GYM
CAFETERIA
COURTYARD
LIBRARY
MDF
AUDITORIUM
TEAM ROOM
LOWER GYM
101
102
103
104
105
106
107
108
110
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211
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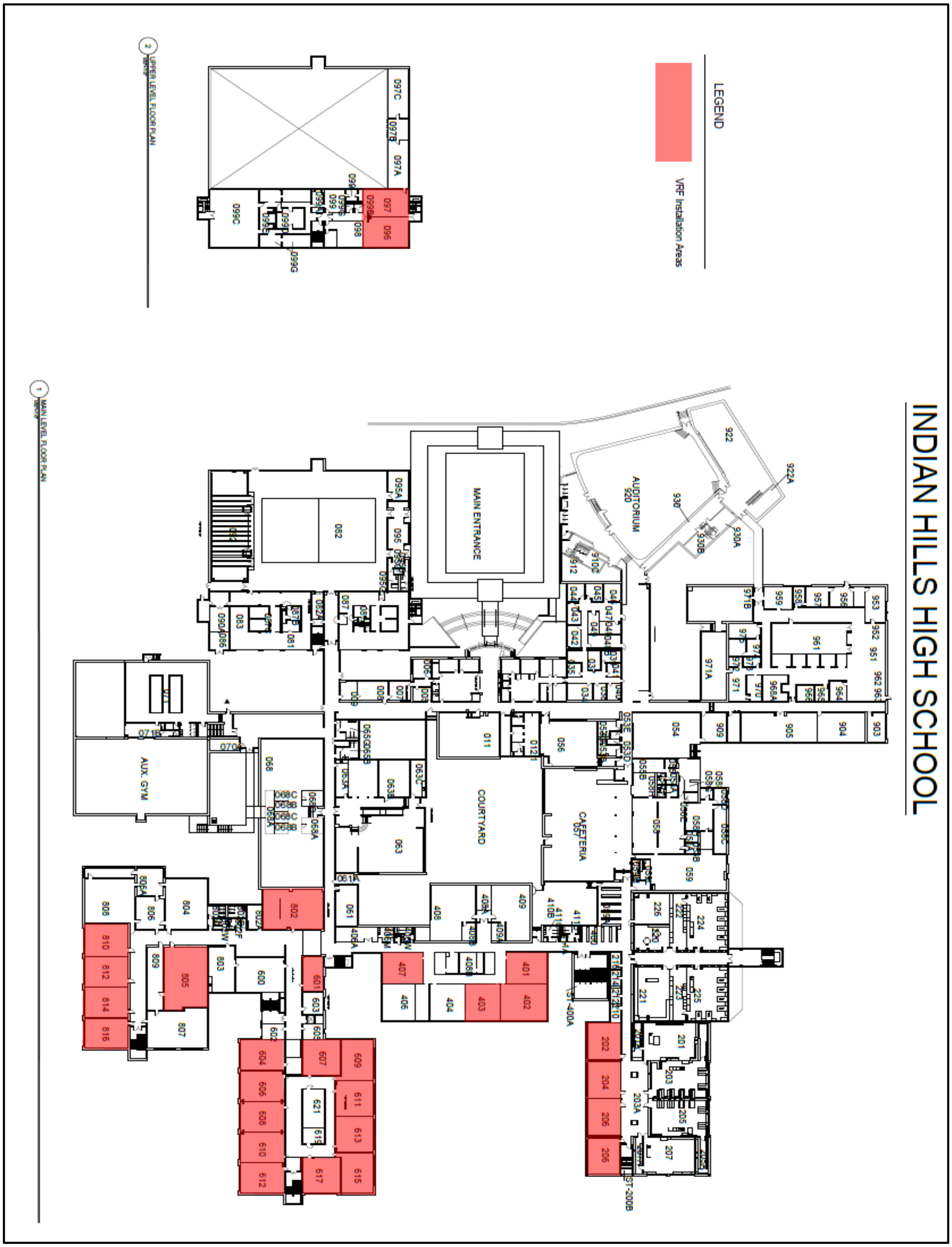
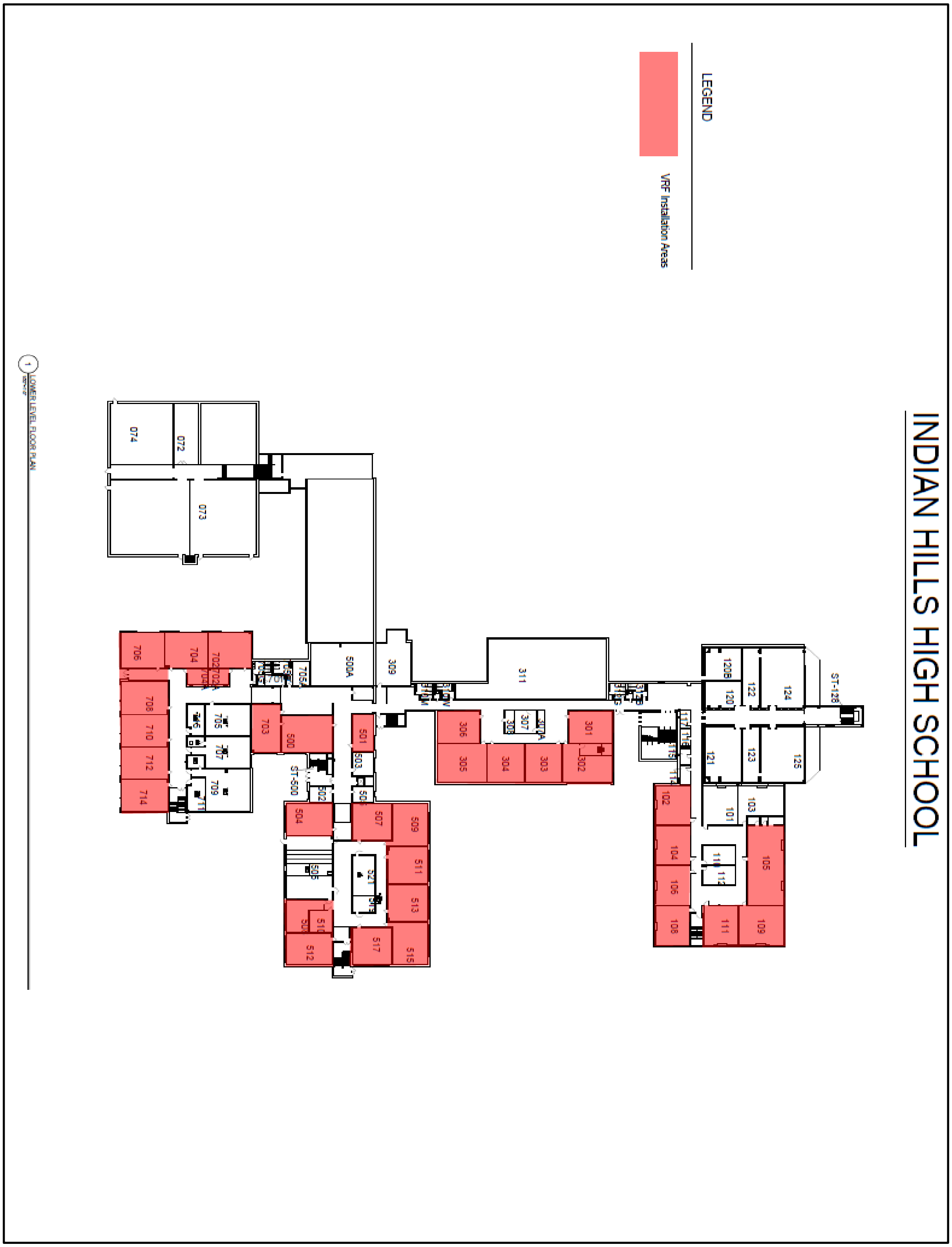

INDIAN HILLS HIGH SCHOOL
LEGEND
VRF Installation Areas


INDIAN HILLS HIGH SCHOOL
LEGEND
VRF Installation Areas
LOWER LEVEL FLOOR PLAN

ECM Calculations

Energy Savings from the installation of VRF units were calculated using BPU protocols. The calculations are shown below. Since the proposed addition of cooling will be an energy increase, the electric kWh savings are shown as a negative.

Existing Qty and Tons per Unit of 0 reflect no current existing D/X Cooling in the proposed spaces for VRF Installation

ADDED VRF - D/X Cooling						
BUILDING	**SYSTEM**	**Areas Served**	**Existing Qty**	**Tons Per Unit**	**Total Existing Tons**	**EERb / SEERb**
Ramapo High School	VRF-Unit Ventilator	CL502, CL504, CL506, CL507, CL505, CL503, CL501	0	0	0.0	0.0
	VRF-Unit Ventilator	CL602, CL604, CL606, CL608, CL601, CL603, CL605, CL207	0	0	0.0	0.0
	VRF-Unit Ventilator	CL227, CL225, CL223, CL221, CL224, CL222, CL220, CL218	0	0	0.0	0.0
	VRF-Unit Ventilator	CL407, CL405, CL401	0	0	0.0	0.0
	VRF-Unit Ventilator	CL304, CL306, CL308, CL310, CL312, CL314, CL316	0	0	0.0	0.0
	VRF-Unit Ventilator	CL318, CL320, CL315, CL313	0	0	0.0	0.0
	VRF-Unit Ventilator	CL311, CL309, CL307, CL305, CL303, CL301	0	0	0.0	0.0
	VRF-Unit Ventilator	CL215, CL213, CL212, CL214	0	0	0.0	0.0
	VRF-Unit Ventilator	CL112, CL110	0	0	0.0	0.0
	VRF-Unit Ventilator	CL108, CL106, CL104, CL102,CL107, CL105, CL103, CL101	0	0	0.0	0.0
Indian Hills High School	CU-Unit Ventilator	CL 802	0	0	0.0	0.0
	VRF-Unit Ventilator	CL810, CL812, CL814, CL816, CL805	0	0	0.0	0.0
	VRF-Unit Ventilator	CL604, CL606, CL608, CL610, CL612	0	0	0.0	0.0
	VRF-Unit Ventilator	CL617, CL615, CL613, CL611, CL609, CL607, CL601	0	0	0.0	0.0
	VRF-Unit Ventilator	CL407, CL403, CL402, CL401	0	0	0.0	0.0
	VRF-Unit Ventilator	CL202, CL204, CL206, CL208	0	0	0.0	0.0
	VRF-Unit Ventilator	CL702, CL704, CL706, CL708, CL710, CL712, CL714	0	0	0.0	0.0
	VRF-Unit Ventilator	CL703, CL500, CL504, CL508, CL512	0	0	0.0	0.0
	VRF-Unit Ventilator	CL517, CL515, CL513, CL511, CL509, CL507, CL501	0	0	0.0	0.0
	VRF-Unit Ventilator	CL306, CL305, CL304, CL303, CL302, CL301	0	0	0.0	0.0
	VRF-Unit Ventilator	CL102, CL104, CL106, CL108, CL111, CL109, CL105, CL105	0	0	0.0	0.0
	VRF-Unit Ventilator	CL097, CL096	0	0	0.0	0.0
	0	0	0	0	0.0	0.0

Proposed Qty and Tons per Unit reflect the proposed VRF Installation

ADDED VRF - D/X Cooling

BUILDING	SYSTEM	Areas Served	Proposed Qty	Tons Per Unit	Total Proposed Tons	EERq / SEERq	CF	EFLH Cooling	Demand Savings (kW)	Energy Savings (kWh)
Ramapo High School	VRF-Unit Ventilator	CL502, CL504, CL506, CL507, CL505, CL503, CL501	1	28.0	28.0	11.7	0.5	466	-14	-13,383
	VRF-Unit Ventilator	CL602, CL604, CL606, CL608, CL601, CL603, CL605, CL207	1	32.0	32.0	11.9	0.5	466	-16	-15,037
	VRF-Unit Ventilator	CL227, CL225, CL223, CL221, CL224, CL222, CL220, CL218	1	32.0	32.0	11.9	0.5	466	-16	-15,037
	VRF-Unit Ventilator	CL407, CL405, CL401	1	12.0	12.0	11.7	0.5	466	-6	-5,735
	VRF-Unit Ventilator	CL304, CL306, CL308, CL310, CL312, CL314, CL316	1	28.0	28.0	11.7	0.5	466	-14	-13,383
	VRF-Unit Ventilator	CL318, CL320, CL315, CL313	1	16.0	16.0	12.2	0.5	466	-8	-7,334
	VRF-Unit Ventilator	CL311, CL309, CL307, CL305, CL303, CL301	1	24.0	24.0	12.2	0.5	466	-12	-11,001
	VRF-Unit Ventilator	CL215, CL213, CL212, CL214	1	16.0	16.0	13.0	0.5	466	-7	-6,882
	VRF-Unit Ventilator	CL112, CL110	1	8.0	8.0	13.0	0.5	466	-4	-3,441
	VRF-Unit Ventilator	CL108, CL106, CL104, CL102,CL107, CL105, CL103, CL101	1	32.0	32.0	11.9	0.5	466	-16	-15,037
Indian Hills High School	CU-Unit Ventilator	CL 802	1	4.0	4.0	12.5	0.5	466	-2	-1,789
	VRF-Unit Ventilator	CL810, CL812, CL814, CL816, CL805	1	24.0	24.0	12.0	0.5	466	-12	-11,184
	VRF-Unit Ventilator	CL604, CL606, CL608, CL610, CL612	1	20.0	20.0	12.0	0.5	466	-10	-9,320
	VRF-Unit Ventilator	CL617, CL615, CL613, CL611, CL609, CL607, CL601	1	28.0	28.0	11.7	0.5	466	-14	-13,383
	VRF-Unit Ventilator	CL407, CL403, CL402, CL401	1	16.0	16.0	13.0	0.5	466	-7	-6,882
	VRF-Unit Ventilator	CL202, CL204, CL206, CL208	1	16.0	16.0	13.0	0.5	466	-7	-6,882
	VRF-Unit Ventilator	CL702, CL704, CL706, CL708, CL710, CL712, CL714	1	28.0	28.0	11.7	0.5	466	-14	-13,383
	VRF-Unit Ventilator	CL703, CL500, CL504, CL508, CL512	1	20.0	20.0	12.0	0.5	466	-10	-9,320
	VRF-Unit Ventilator	CL517, CL515, CL513, CL511, CL509, CL507, CL501	1	28.0	28.0	11.7	0.5	466	-14	-13,383
	VRF-Unit Ventilator	CL306, CL305, CL304, CL303, CL302, CL301	1	24.0	24.0	12.2	0.5	466	-12	-11,001
	VRF-Unit Ventilator	CL102, CL104, CL106, CL108, CL111, CL109, CL105, CL105	1	32.0	32.0	11.9	0.5	466	-16	-15,037
	VRF-Unit Ventilator	CL097, CL096	1	8.0	8.0	13.0	0.5	466	-4	-3,441
	0	0	0	0	0.0		0.5		0	0

VRF Installation - Total Savings

BUILDING NAME	SYSTEM	Annual Electric Savings (kWh)	Total Electric Savings (kWh)	Annual Demand Savings (kW)	Total Demand Savings (kW)	Annual Gas Savings (Therms)	Total Gas Savings (Therms)
Ramapo High School	VRF-Unit Ventilator	(13,383)		(14)		-	
Ramapo High School	VRF-Unit Ventilator	(15,037)		(16)		-	
Ramapo High School	VRF-Unit Ventilator	(15,037)		(16)		-	
Ramapo High School	VRF-Unit Ventilator	(5,735)		(6)		-	
Ramapo High School	VRF-Unit Ventilator	(13,383)	(106,271)	(14)	(114)	-	-
Ramapo High School	VRF-Unit Ventilator	(7,334)		(8)		-	
Ramapo High School	VRF-Unit Ventilator	(11,001)		(12)		-	
Ramapo High School	VRF-Unit Ventilator	(6,882)		(7)		-	
Ramapo High School	VRF-Unit Ventilator	(3,441)		(4)		-	
Ramapo High School	VRF-Unit Ventilator	(15,037)		(16)		-	
Indian Hills High School	CU-Unit Ventilator	(1,789)		(2)		-	
Indian Hills High School	VRF-Unit Ventilator	(11,184)		(12)		-	
Indian Hills High School	VRF-Unit Ventilator	(9,320)		(10)		-	
Indian Hills High School	VRF-Unit Ventilator	(13,383)		(14)		-	
Indian Hills High School	VRF-Unit Ventilator	(6,882)		(7)		-	
Indian Hills High School	VRF-Unit Ventilator	(6,882)		(7)		-	
Indian Hills High School	VRF-Unit Ventilator	(13,383)	(115,005)	(14)	(123)	-	-
Indian Hills High School	VRF-Unit Ventilator	(9,320)		(10)		-	
Indian Hills High School	VRF-Unit Ventilator	(13,383)		(14)		-	
Indian Hills High School	VRF-Unit Ventilator	(11,001)		(12)		-	
Indian Hills High School	VRF-Unit Ventilator	(15,037)		(16)		-	
Indian Hills High School	VRF-Unit Ventilator	(3,441)		(4)		-	
Indian Hills High School	0	-		-		-	

Definition of Variables

N = Number of units

Tons = Rated cooling capacity of unit.This value comes from ARI/AHRI or AHAM rating or manufacturer data.

EER_b = Energy Efficiency Ratio of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER should be used in place of EER.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

EER_q = Energy Efficiency Ratio of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 (5.4 tons) BtuH, SEER should be used in place of EER.

COP_q = Coefficient of Performance of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value is based on existing measured usage and determined as the average number of operating hours during the peak window period.

$EFLH_{c\ or\ h}$ = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off-peak periods.

Summary of Inputs

HVAC and Heat Pumps

Component	Type	Value	Source
Tons	Variable	Rated Capacity, Tons	Application
EER_b	Variable	See Table below	1
EER_q	Variable	ARI/AHRI or AHAM Values	Application
CF	Fixed	50%	2
$EFLH_{(c\ or\ h)}$	Variable	See Tables below	3

HVAC Baseline Efficiencies Table – New Construction/EUL/RoF

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2016
Unitary HVAC/Split Systems and Single Package, Air Cooled	
<=5.4 tons, split	14 SEER
<=5.4 tons, single	14 SEER
>5.4 to 11.25 tons	11.0 EER, 12.7 IEER
>11.25 to 20 tons	10.8 EER, 12.2 IEER
> 21 to 63 tons	9.8 EER, 11.4 IEER
>63 Tons	9.5 EER, 11.0 IEER
Air Cooled Heat Pump Systems, Split System and Single Package	
<=5.4 tons, split	14 SEER, 8.2 HSPF
<=5.4 tons, single	14 SEER, 8.0 HSPF
>5.4 to 11.25 tons	10.8 EER, 12 IEER, 3.3 heating COP
>11.25 to 20 tons	10.4 EER, 11.4 IEER, 3.2 heating COP
>= 21	9.3 EER, 10.4 IEER, 3.2 heating COP

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2016
Water Source Heat Pumps (water to air, water loop)	
<=1.4 tons	12.2 EER, 4.3 heating COP
>1.4 to 5.4 tons	13.0 EER, 4.3 heating COP
>5.4 to 11.25 tons	13.0 EER, 4.3 heating COP
Ground Water Source Heat Pumps <=11.25 tons	18.0 EER, 3.7 heating COP
Ground Source Heat Pumps (brine to air, ground loop) <=11.25 tons	14.1 EER, 3.2 heating COP
Package Terminal Air Conditioners[57]	14.0 – (0.300 * Cap/1,000), EER
Package Terminal Heat Pumps	14.0 – (0.300 * Cap/1,000), EER 3.7 – (0.052 * Cap/1,000), heating COP
Single Package Vertical Air Conditioners	
<=5.4 tons	10.0 EER
>5.4 to 11.25 tons	10.0 EER
>11.25 to 20 tons	10.0 EER
Single Package Vertical Heat Pumps	
<=5.4 tons	10.0 EER, 3.0 heating COP
>5.4 to 11.25 tons	10.0 EER, 3.0 heating COP
>11.25 to 20 tons	10.0 EER, 3.0 heating COP

Algorithms

Air Conditioning Algorithms:

Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q)$ * $EFLH_c$

Peak Demand Savings (kW) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q)$ * CF

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

Algorithms

Energy Savings (kWh/yr) = N * HP * ESF

Peak Demand Savings (kW) = N * HP * DSF

Definitions of Variables

N = Number of motors controlled by VFD(s) per application

HP = Nameplate motor horsepower or manufacturer specification sheet per application

ESF = Energy Savings Factor (kWh/year per HP)

DSF = Demand Savings Factor (kW per HP)

Summary of Inputs

Variable Frequency Drives

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
ESF	Variable	See Table Below	Derived value based on the following sources: 1, 2, 3
DSF	Variable	See Table Below	Derived value based on the following sources: 1, 2, 3

The ESF for the supply and return fans and circulating pumps are derived from a 2014 NEEP-funded study of 400 VFD installations in eight northeast states. The derived values are based on actual logged input power data and reflect average operating hours, load factors, and motor efficiencies for the sample. Savings factors representing cooling tower fans and boiler feed water pumps are not reflected in the NEEP report. Values representing these applications are taken from April 2018 New York TRM, Appendix K, and represent average values derived from DOE2.2 simulation of various building types

ECM 19 – Rooftop Unit and VRF Installation

RAMAPO INDIAN HILLS RHSD

✔	ECM evaluated but not included
✔ (green)	ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
19	Rooftop Unit and VRF Installation	✔	✔

In addition to adding cooling to 117 classrooms between both high schools (reflected in ECM 18), Ramapo Indian Hills Regional High School District has expressed interest in the addition of cooling to larger spaces. This measure includes spaces such as main and auxiliary gyms, locker rooms, cafeterias and teams' rooms which are currently uncooled at both high schools. DCO Energy has explored an array of options to cool these specific spaces, including the installation of new direct expansion rooftop units and adding addition variable refrigerant flow systems where applicable.

High Efficiency Rooftop unit

Existing Conditions

Ramapo High School

Main Gymnasium

Two (2) rooftop heating and ventilation units serve the main gymnasium. Both units utilize natural gas burners for suppling heat to the space. These units are approximately 19 years old and are past ASHREA's useful life metric.

Main Gymnasium Locker Rooms

Similar to the main gymnasium, two (2) rooftop heating and ventilation units serve the boy's and girl's locker rooms. Both units utilize natural gas burners for suppling heat to the space. The boy's locker room unit is approximately 19 years old. The girl's locker room unit is two years old and was recently installed.

Cafeteria:

One (1) DX cooling natural gas fired rooftop unit serves the cafeteria. This unit is seven years old was evaluated to be in adequate shape. When this rooftop unit was installed the DX cooling portion was never powered.

Auxiliary Gymnasium

Two (2) vertical hot water air handling units serve the auxiliary gymnasium. Although these units have substantial age, they have been refurbished in the last seven years.

Auxiliary Gymnasium Locker Rooms

Similar to the Auxiliary Gymnasium, one (1) vertical hot water air handling unit serves these locker rooms. Although the unit has substantial age, it has been refurbished in the last seven years.

613D & 613 Team Room

Two (2) hot water unit ventilators serve both teams rooms: one unit ventilator per each space.

613 Office and Storage (3 Spaces)

Fin tube hot water radiant heat serve these spaces.


Existing unit rooftop H&V unit and internal AHU at Ramapo HS

Indian Hills High School

Main Gymnasium

One (1) internal hot water air handling unit serves the main gymnasium. This unit is located in a mechanical penthouse adjacent to the gym.

Main Gymnasium Locker Rooms/Teams Room

Similar to the main gymnasium, three (3) internal hot water air handling units serve the boy's and girl's locker rooms and team's room; one per each space. These units are located in a second-floor mechanical room near the conditioned spaces.

Cafeteria:

Three (3) internal hot water air handlers serve the cafeteria area of the high school. There is one (1) main air handler for the cafeteria and two (2) smaller air handlers serving the spaces adjacent. The larger cafeteria unit is in a mechanical closet, while the smaller air handlers are located above the ceiling.

Auxiliary Gymnasium/Fitness Center/Girl's Locker Room:

The gym and locker rooms are served by two (2) two gas-fired heating and ventilation units located on the roof. One of the units serves the Auxiliary Gymnasium while the other unit serves the locker room and Fitness Center. These units are approximately seven years old.

Band Rooms:

The band rooms are served by an existing gas-fired heating and ventilation unit located on the roof. This unit is approximately seven years old.

Home Economics Rooms

These two spaces are served by one (1) internal hot water air handling unit. The unit is located in a mechanical closet and is ducted into both classrooms.


Existing unit rooftop H&V unit and internal AHU at Indian Hills HS

Scope of Work

Ramapo High School

Cafeteria (Existing RTU)

- Electrical
  - Provide new electrical power for existing rooftop unit, including new breaker, conduit, wiring, disconnect, service receptacle, etc as required.

Main Gymnasium and Main Gymnasium Locker Rooms

- Remove four (4) existing heating only rooftop units that serve each space.
- Furnish and install two (2) new 25 Ton packaged rooftop units (Gym) and two (2) 15 Ton packaged RTU (Boys/Girls Locker Rooms). Existing ductwork may be re-used to the maximum extent possible provided that the ductwork is insulated or can be fully insulated.
- RTU's shall have DX cooling and natural gas fired heating.
- Reconnect existing gas piping to new units. Provide new regulators if required.
- New rooftop units shall be installed on existing roof curb/supports. Provide all roof and structural modifications required for installation of new RTU including curb adapters (if required).
- Electrical
  - Disconnect and remove existing electrical wiring, conduit and breaker(s) that serve the existing RTUs.
  - Provide new electrical power for rooftop units, including new breakers, conduit, wiring, disconnect, service receptacle, etc as required.

<u>Auxiliary Gymnasium</u>

- Remove existing heating only air handling units in mechanical room.
- Furnish and install two new 20-Ton packaged rooftop units. Existing ductwork may be re-used to the maximum extent possible provided that the ductwork is insulated or can be fully insulated. Existing is rectangular and uninsulated, this should be replaced with double wall, insulated spiral duct.
- Install new hydronic heating coils in main supply ductwork below the roof for RTUs/spaces served.
- New rooftop units shall be installed on new roof curb/supports. Provide all roof and structural modifications required for installation of new RTU.
- Electrical
    - Provide new electrical power for rooftop units, including new breaker, conduit, wiring, disconnect, service receptacle, etc as required.
    - Power for new RTU should be coordinated with new power being provided for classroom unit ventilators.

<u>Auxiliary Gymnasium Locker Rooms / 613 Teams Rooms/ 613 Office and Storage</u>

- Remove existing heating only air handling unit in mechanical room that serves the locker rooms.
- Remove exiting heating only horizonal UVs that serve the team room
- Furnish and install one new 10-Ton packaged rooftop units. Existing ductwork may be re-used to the maximum extent possible provided that the ductwork is insulated or can be fully insulated.
- Install new hydronic heating coils in main supply ductwork below the roof for RTU/space served.
- New rooftop units shall be installed on new roof curb/supports. Provide all roof and structural modifications required for installation of new RTU.
- Remove and replace two (2) indoor horizonal, ceiling hung heating only unit ventilators in team room. Furnish and install two (2) new ceiling hung UVs with DX cooling and hot water heating. New UVs shall be served by a new 5 Ton VRF CU.
- Furnish and install one (1) VRF with DX cooling for 613 Offices and storage. New VRF shall be 5-Tons and have 1 indoor cassette, one per each space.
- Electrical
    - Provide new electrical power for rooftop units, including new breaker, conduit, wiring, disconnect, service receptacle, etc as required.

- Power for new RTU should be coordinated with new power being provided for classroom unit ventilators.

Indian Hills High School

Cafeteria

- Remove existing heating only air handling unit located in mechanical closet adjacent to space. Cut and cap existing hot water supply return piping.
- Furnish and install one new 15 Ton packaged rooftop unit over existing space and provide new supply/return duct distribution in space. Existing ductwork may be re-used to the maximum extent possible provided that the ductwork is insulated or can be fully insulated.
- RTU's shall have DX cooling and natural gas fired heating.
- Provide new gas piping the RTU. Gas piping shall be extended from nearest gas branch/main on roof. Provide new gas regulator and shut off valve.
- New rooftop unit shall be installed on new roof curb. Provide all roof and structural modifications required for installation of new RTU.
- Electrical
    - Disconnect and remove existing electrical wiring, conduit and breaker(s) that serve the existing indoor unit.
    - Provide new electrical power for rooftop unit, including new breaker, conduit, wiring, disconnect, service receptacle, etc as required.

Cafeteria Left (Room 056) and Cafeteria Right (Room 410B)

- Remove existing heating only air handling unit located above the ceiling in each space. Cut and cap existing hot water supply return piping.
- Furnish and install two new 7.5 Ton packaged rooftop units over existing spaces and provide new supply/return duct distribution. Existing ductwork may be re-used to the maximum extent possible provided that the ductwork is insulated or can be fully insulated.
- RTU's shall have DX cooling and natural gas fired heating.
- Provide new gas piping to each unit. Gas piping shall be extended from nearest gas branch/main on roof. Provide new gas regulator(s) and shut off valves.
- New rooftop units shall be installed on new roof curbs. Provide all roof and structural modifications required for installation of new RTU.
- Electrical
    - Disconnect and remove existing electrical wiring, conduit and breaker(s) that serve the existing indoor units.

- Provide new electrical power for rooftop units, including new breaker, conduit, wiring, disconnect, service receptacle, etc as required.

Economics Classrooms (408/409)

- Furnish and install one 10 Ton VAV RTU with gas fired heating section.
- Furnish and install 3 new VAV boxes (1 per space) with HW reheat coils.
- Provide all new duct and hydronic piping distribution.
- RTU's shall have DX cooling and natural gas fired heating.
- Provide new gas piping to each unit. Gas piping shall be extended from nearest gas branch/main on roof. Provide new gas regulator(s) and shut off valves.
- New rooftop units shall be installed on new roof curbs. Provide all roof and structural modifications required for installation of new RTU.
- Electrical
  - Disconnect and remove existing electrical wiring, conduit and breaker(s) that serve the existing indoor unit.
  - Provide new electrical power for rooftop units, including new breakers, conduit, wiring, disconnect, service receptacle, etc as required.

Main Gymnasium

- Remove existing heating only air handling unit in penthouse.
- Furnish and install two new 25-Ton packaged rooftop units with gas fired heating Existing ductwork may be re-used to the maximum extent possible provided that the ductwork is insulated or can be fully insulated. Existing duct is rectangular and uninsulated, expect to replace with double wall spiral
- New rooftop units shall be installed on new roof curb/supports. Provide all roof and structural modifications required for installation of new RTU.
- Electrical
  - Provide new electrical power for rooftop units, including new breaker, conduit, wiring, disconnect, service receptacle, etc as required.
  - Power for new RTU should be coordinated with new power being provided for classroom unit ventilators.

Main Gymnasium Locker Rooms/Teams Room

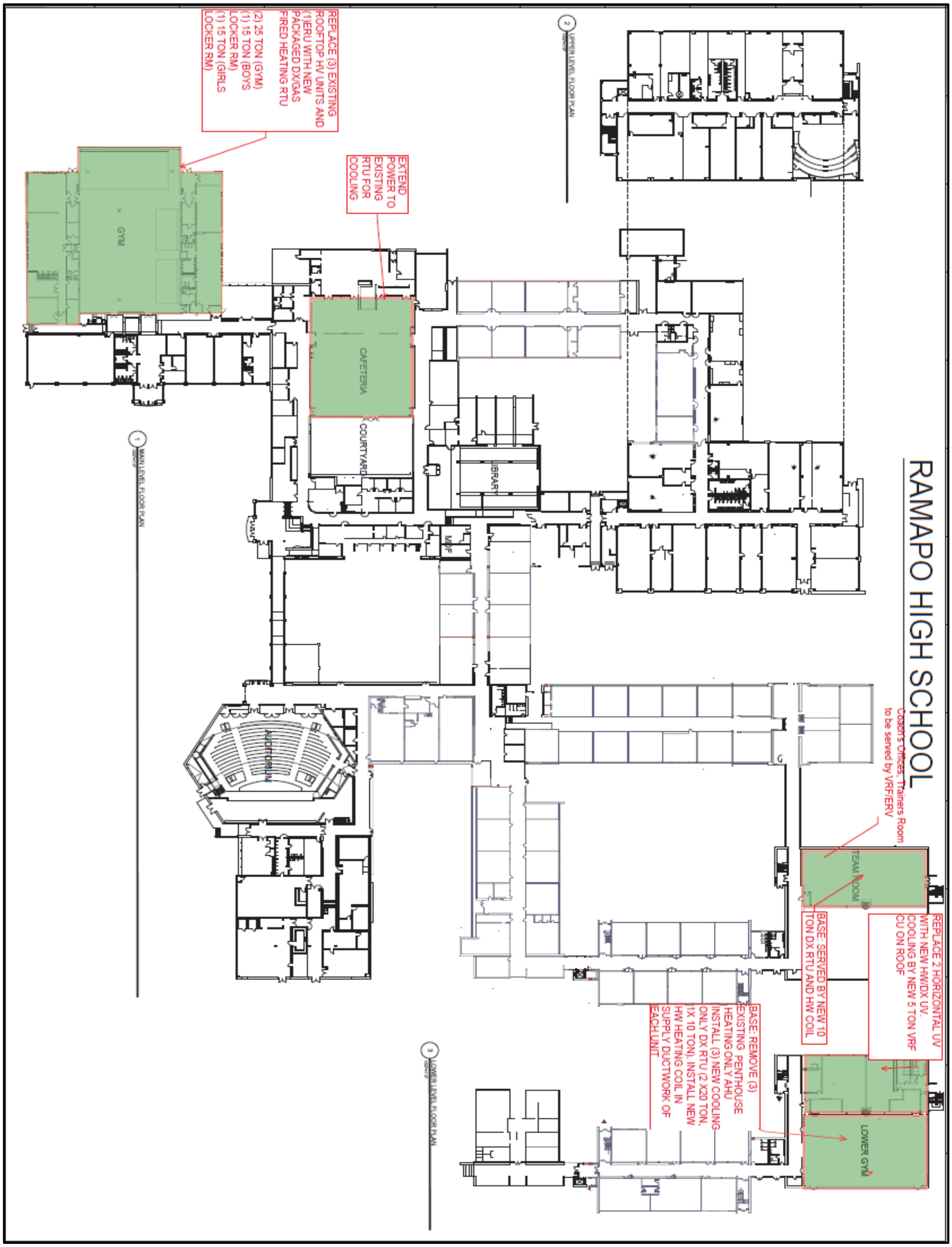
- Remove 3 existing heating only AHU in penthouse that serve each space.
- Furnish and install 3 new 10 Ton RTUs

- New rooftop units shall be installed on new roof curb/supports. Provide all roof and structural modifications required for installation of new RTU.
- Install new hydronic heating coils in main supply ductwork below the roof for each RTU/space served.
- Existing ductwork may be re-used to the maximum extent possible provided that the ductwork is insulated or can be fully insulated. Run new supply/return ductwork as required to serve each space.
- Electrical
    - Provide new electrical power for condensing units and indoor units, including new breakers, conduit, wiring, disconnect, service receptacle, etc as required.
    - Power for VRF system should be coordinated with new power being provided for classroom unit ventilators

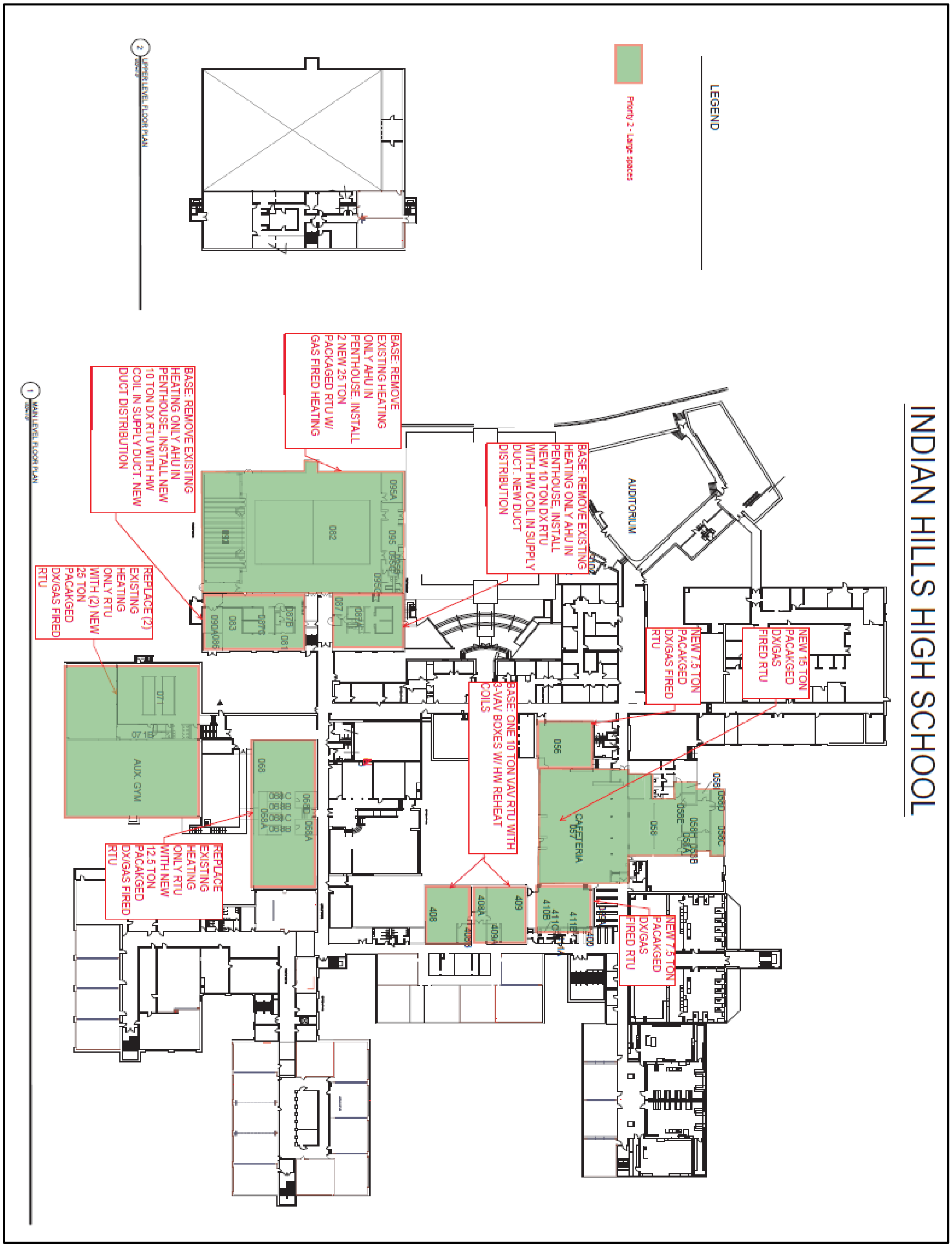
Auxiliary Gym, Weight Room/Locker Room, and Music Room

- Remove existing heating only rooftop units that serve each space.
- Furnish and install two new 25 Ton packaged rooftop units (Aux Gym and Weight Room) and one 12.5 Ton packaged RTU (music room). Existing ductwork may be re-used to the maximum extent possible provided that the ductwork is insulated or can be fully insulated.
- RTU's shall have DX cooling and natural gas fired heating.
- Reconnect existing gas piping to new units. Provide new regulators if required.
- New rooftop units shall be installed on existing roof curb/supports. Provide all roof and structural modifications required for installation of new RTU including curb adapters (if required).
- Electrical
    - Disconnect and remove existing electrical wiring, conduit and breaker(s) that serve the existing RTUs.
    - Provide new electrical power for rooftop units, including new breakers, conduit, wiring, disconnect, service receptacle, etc as required.

RTU/VRF Installation Scope of Work					
BUILDING	**CATEGORY**	**AREA SERVED**	**Tons**	**QUANTITY**	**NOTES**
Ramapo High School	Rooftop Unit	Boys Locker Room	15	1	D/X Gas-Fired RTU replaces existing Gas-Fired Rooftop HV Unit
	Rooftop Unit	Main Gym Right	25	1	D/X Gas-Fired RTU replaces existing Gas-Fired Rooftop HV Unit
	Rooftop Unit	Main Gym Left	25	1	D/X Gas-Fired RTU replaces existing Gas-Fired Rooftop HV Unit
	Rooftop Unit	Girls Locker Room	15	1	D/X Gas-Fired RTU replaces existing Gas-Fired Rooftop HV Unit
	Rooftop Unit	Lower Gym South	20	1	D/X RTU with HW Coil in Ductwork replaces existing HW AHU
	Rooftop Unit	Lower Gym North	20	1	D/X RTU with HW Coil in Ductwork replaces existing HW AHU
	Rooftop Unit	Lower Gym Lower Level Lockers	10	1	D/X RTU with HW Coil in Ductwork replaces existing HW AHU
	UV/VRF	613D Team Room	5	1	HW/VRF Unit Ventilator replaces existing HW Unit Ventilator - 1 VRF for both Team Rooms
	UV/VRF	613 Team Room		1	HW/VRF Unit Ventilator replaces existing HW Unit Ventilator - 1 VRF for both Team Rooms
	ERU/VRF	613, 613, 613A	5	1	Energy Recovery Unit for Ventilation and VRF with 3 Cassettes Installation
Indian Hills High School	Rooftop Unit	Cafeteria	15	1	D/X Gas-Fired RTU replaces existing internal HW AHU
	Rooftop Unit	056 (Café Left)	7.5	1	D/X Gas-Fired RTU replaces existing internal HW AHU
	Rooftop Unit	410B (Café Right)	7.5	1	D/X Gas-Fired RTU replaces existing internal HW AHU
	VAV Rooftop Unit	409/408 Economics	10	1	D/X VAV RTU with HW Reheat replaces existing internal HW AHU
	Rooftop Unit	Aux Gym	25	1	D/X Gas-Fired RTU replaces existing Gas-Fired Rooftop HV Unit
	Rooftop Unit	Weight Room / Locker	25	1	D/X Gas-Fired RTU replaces existing Gas-Fired Rooftop HV Unit
	Rooftop Unit	Music Classrooms	12.5	1	D/X Gas-Fired RTU replaces existing Gas-Fired Rooftop HV Unit
	Rooftop Unit	Main Gym	25	1	D/X Gas-Fired RTU replaces existing internal HW AHU
	Rooftop Unit	Main Gym	25	1	D/X Gas-Fired RTU replaces existing internal HW AHU
	Rooftop Unit	Girls Locker Room	10	1	D/X RTU with HW Coil in Ductwork replaces existing HW AHU
	Rooftop Unit	Boys Locker Room	10	1	D/X RTU with HW Coil in Ductwork replaces existing HW AHU
	Rooftop Unit	Trainers Room	10	1	D/X RTU with HW Coil in Ductwork replaces existing HW AHU



RAMAPO HIGH SCHOOL
REPLACE (3) EXISTING ROOFTOP HV UNITS AND (1)ERU WITH NEW PACKAGED DX/GAS FIRED HEATING RTU
(2) 25 TON (GYM)
(1) 15 TON (BOYS LOCKER RM)
(1) 15 TON (GIRLS LOCKER RM)
EXTEND POWER TO EXISTING RTU FOR COOLING
GYM
CAFETERIA
COURTYARD
LIBRARY
MDF
AUDITORIUM
Coach's Offices, Trainers Room to be served by VRF/ERV
TEAM ROOM
REPLACE 2 HORIZONTAL UV WITH NEW HW/DX UV. COOLING BY NEW 5 TON VRF CU ON ROOF
BASE: SERVED BY NEW 10 TON DX RTU AND HW COIL
BASE: REMOVE (3) EXISTING PENTHOUSE HEATING ONLY AHU INSTALL (3) NEW COOLING ONLY DX RTU (2 X20 TON, 1X 10 TON). INSTALL NEW HW HEATING COIL IN SUPPLY DUCTWORK OF EACH UNIT
LOWER GYM


INDIAN HILLS HIGH SCHOOL
LEGEND
Priority 2 - Large spaces
BASE: REMOVE EXISTING HEATING ONLY AHU IN PENTHOUSE. INSTALL 2 NEW 25 TON PACKAGED RTU W/ GAS FIRED HEATING
BASE: REMOVE EXISTING HEATING ONLY AHU IN PENTHOUSE. INSTALL NEW 10 TON DX RTU WITH HW COIL IN SUPPLY DUCT. NEW DUCT DISTRIBUTION
BASE: REMOVE EXISTING HEATING ONLY AHU IN PENTHOUSE. INSTALL NEW 10 TON DX RTU WITH HW COIL IN SUPPLY DUCT. NEW DUCT DISTRIBUTION
REPLACE (2) EXISTING HEATING ONLY RTU WITH (2) NEW 25 TON PACKAGED DX/GAS FIRED RTU
BASE: ONE 10 TON VAV RTU WITH 3-VAV BOXES W/ HW REHEAT COILS
REPLACE EXISTING HEATING ONLY RTU WITH NEW 12.5 TON PACAKGED DX/GAS FIRED RTU
NEW 7.5 TON PACKAGED DX/GAS FIRED RTU
NEW 15 TON PACAKGED DX/GAS FIRED RTU
NEW 7.5 TON PACKAGED DX/GAS FIRED RTU
AUDITORIUM
CAFETERIA
AUX. GYM
UPPER LEVEL FLOOR PLAN
MAIN LEVEL FLOOR PLAN

ECM Calculations

Energy Savings from the installation of Rooftop and VRF units were calculated using BPU protocols. The calculations are shown below. Since the proposed addition of cooling will be an energy increase, the electric kWh savings are shown as a negative.

CALCULATED SAVINGS

RTU/UV/ERU Installation - Fan Savings

BUILDING	SYSTEM	Areas Served	QTY	Fan QTY	EXISTING FAN HP	PROPOSED FAN HP	EXISTING MOTOR EFFICIENCY (Nbase)	REPLACEMENT MOTOR EFFICIENCY (Nprem)
Ramapo High School	Rooftop Unit	Boys Locker Room	1	1	5	5	86.5%	89.5%
	Rooftop Unit	Main Gym Right	1	1	15	15	89.4%	92.4%
	Rooftop Unit	Main Gym Left	1	1	15	15	89.4%	92.4%
	Rooftop Unit	Girls Locker Room	1	1	5	5	89.5%	89.5%
	Rooftop Unit	Lower Gym South	1	1	10	10	89.7%	91.7%
	Rooftop Unit	Lower Gym North	1	1	10	10	89.7%	91.7%
	Rooftop Unit	Lower Gym Lower Level Lockers	1	1	3.0	3	87.5%	89.5%
	UV/VRF	613D Team Room	1	1	0.3	0.3	82.5%	85.5%
	UV/VRF	613 Team Room	1	1	0.3	0.3	82.5%	85.5%
	ERU/VRF	613, 613, 613A	1	1	0.0	5.0	0.0%	89.5%
Indian Hills High School	Rooftop Unit	Cafeteria	1	1	10.0	10.0	88.7%	91.7%
	Rooftop Unit	056 (Café Left)	1	1	3.0	3.0	86.5%	89.5%
	Rooftop Unit	410B (Café Right)	1	1	3.0	3.0	86.5%	89.5%
	VAV Rooftop Unit	409/408 Economics	1	1	5.0	5.0	86.5%	89.5%
	Rooftop Unit	Aux Gym	1	1	5.0	5.0	88.5%	89.5%
	Rooftop Unit	Weight Room / Locker	1	1	5.0	5.0	88.5%	89.5%
	Rooftop Unit	Music Classrooms	1	1	1.5	1.5	85.5%	86.5%
	Rooftop Unit	Main Gym	1	1	10.0	10.0	88.7%	91.7%
	Rooftop Unit	Main Gym	1	1	10.0	10.0	88.7%	91.7%
	Rooftop Unit	Girls Locker Room	1	1	5.0	5.0	86.5%	89.5%
	Rooftop Unit	Boys Locker Room	1	1	5.0	5.0	86.5%	89.5%
	Rooftop Unit	Trainers Room	1	1	5.0	5.0	86.5%	89.5%

RTU/UV/ERU Installation - Fan Savings

BUILDING	SYSTEM	Areas Served	LF	CF	IFvfd	HRS	ΔkW	PREM. MOTOR DEMAND SAVINGS (kW)	PREM. MOTOR ELECTRIC SAVINGS (kWh)	TOTAL DEMAND SAVINGS (kW)	TOTAL ELECTRIC SAVINGS (kWh)
Ramapo High School	Rooftop Unit	Boys Locker Room	0.75	0.74	1.0	2,745	0.14	0.11	298	0.1	298
	Rooftop Unit	Main Gym Right	0.75	0.74	1.0	3,391	0.41	0.30	1,034	0.3	1,034
	Rooftop Unit	Main Gym Left	0.75	0.74	1.0	3,391	0.41	0.30	1,034	0.3	1,034
	Rooftop Unit	Girls Locker Room	0.75	0.74	1.0	2,745	0.00	0.00	0	0.0	0
	Rooftop Unit	Lower Gym South	0.75	0.74	1.0	3,391	0.18	0.13	461	0.1	461
	Rooftop Unit	Lower Gym North	0.75	0.74	1.0	3,391	0.18	0.13	461	0.1	461
	Rooftop Unit	Lower Gym Lower Level Lockers	0.75	0.74	1.0	2,745	0.06	0.04	118	0.0	118
	UV/VRF	613D Team Room	0.75	0.74	1.0	2,745	0.01	0.01	16	0.0	16
	UV/VRF	613 Team Room	0.75	0.74	1.0	2,745	0.01	0.01	16	0.0	16
	ERU/VRF	613, 613, 613A	0.75	0.74	1.0	2,745	(4.17)	(3.08)	(8,580)	(3.1)	(8,580)
Indian Hills High School	Rooftop Unit	Cafeteria	0.75	0.74	1.0	3,391	0.28	0.20	700	0.2	700
	Rooftop Unit	056 (Café Left)	0.75	0.74	1.0	2,745	0.09	0.06	179	0.1	179
	Rooftop Unit	410B (Café Right)	0.75	0.74	1.0	2,745	0.09	0.06	179	0.1	179
	VAV Rooftop Unit	409/408 Economics	0.75	0.74	1.0	2,745	0.14	0.11	298	0.1	298
	Rooftop Unit	Aux Gym	0.75	0.74	1.0	2,745	0.05	0.03	97	0.0	97
	Rooftop Unit	Weight Room / Locker	0.75	0.74	1.0	2,745	0.05	0.03	97	0.0	97
	Rooftop Unit	Music Classrooms	0.75	0.74	1.0	2,745	0.02	0.01	31	0.0	31
	Rooftop Unit	Main Gym	0.75	0.74	1.0	3,391	0.28	0.20	700	0.2	700
	Rooftop Unit	Main Gym	0.75	0.74	1.0	3,391	0.28	0.20	700	0.2	700
	Rooftop Unit	Girls Locker Room	0.75	0.74	1.0	2,745	0.14	0.11	298	0.1	298
	Rooftop Unit	Boys Locker Room	0.75	0.74	1.0	2,745	0.14	0.11	298	0.1	298
	Rooftop Unit	Trainers Room	0.75	0.74	1.0	2,745	0.14	0.11	298	0.1	298

Qty and Tons per Unit of 0 reflect no current existing D/X Cooling in the proposed spaces for RTU/VRF Installation

CALCULATED SAVINGS

RTU/VRF - D/X Cooling

BUILDING	SYSTEM	Areas Served	Existing Qty	Tons Per Unit	Total Existing Tons	EERb / SEERb
Ramapo High School	Rooftop Unit	Boys Locker Room	0	0	0.0	0.0
	Rooftop Unit	Main Gym Right	0	0	0.0	0.0
	Rooftop Unit	Main Gym Left	0	0	0.0	0.0
	Rooftop Unit	Girls Locker Room	0	0	0.0	0.0
	Rooftop Unit	Lower Gym South	0	0	0.0	0.0
	Rooftop Unit	Lower Gym North	0	0	0.0	0.0
	Rooftop Unit	Lower Gym Lower Level Lockers	0	0	0.0	0.0
	UV/VRF	613D Team Room	0	0	0.0	0.0
	UV/VRF	613 Team Room	0	0	0.0	0.0
	ERU/VRF	613, 613, 613A	0	0	0.0	0.0
Indian Hills High School	Rooftop Unit	Cafeteria	0	0	0.0	0.0
	Rooftop Unit	056 (Café Left)	0	0	0.0	0.0
	Rooftop Unit	410B (Café Right)	0	0	0.0	0.0
	VAV Rooftop Unit	409/408 Economics	0	0	0.0	0.0
	Rooftop Unit	Aux Gym	0	0	0.0	0.0
	Rooftop Unit	Weight Room / Locker	0	0	0.0	0.0
	Rooftop Unit	Music Classrooms	0	0	0.0	0.0
	Rooftop Unit	Main Gym	0	0	0.0	0.0
	Rooftop Unit	Main Gym	0	0	0.0	0.0
	Rooftop Unit	Girls Locker Room	0	0	0.0	0.0
	Rooftop Unit	Boys Locker Room	0	0	0.0	0.0
	Rooftop Unit	Trainers Room	0	0	0.0	0.0

Proposed Qty and Tons per Unit reflect the proposed VRF Installation

RTU/VRF - D/X Cooling

BUILDING	SYSTEM	Areas Served	Proposed Qty	Tons Per Unit	Total Proposed Tons	EERq / SEERq	CF	EFLH Cooling	Demand Savings (kW)	Energy Savings (kWh)
Ramapo High School	Rooftop Unit	Boys Locker Room	1	15.0	15.0	12.0	0.5	466	-8	-6,990
	Rooftop Unit	Main Gym Right	1	25.0	25.0	11.2	0.5	466	-13	-12,482
	Rooftop Unit	Main Gym Left	1	25.0	25.0	11.2	0.5	466	-13	-12,482
	Rooftop Unit	Girls Locker Room	1	15.0	15.0	12.0	0.5	466	-8	-6,990
	Rooftop Unit	Lower Gym South	1	20.0	20.0	11.8	0.5	466	-10	-9,478
	Rooftop Unit	Lower Gym North	1	20.0	20.0	11.8	0.5	466	-10	-9,478
	Rooftop Unit	Lower Gym Lower Level Lockers	1	10.0	10.0	12.0	0.5	466	-5	-4,660
	UV/VRF	613D Team Room	1	5.0	5.0	13.0	0.5	466	-2	-2,151
	UV/VRF	613 Team Room	1	0.0	0.0	13.0	0.5	466	0	0
	ERU/VRF	613, 613, 613A	1	5.0	5.0	13.0	0.5	466	-2	-2,151
Indian Hills High School	Rooftop Unit	Cafeteria	1	15.0	15.0	12.0	0.5	466	-8	-6,990
	Rooftop Unit	056 (Café Left)	1	7.5	7.5	12.0	0.5	466	-4	-3,495
	Rooftop Unit	410B (Café Right)	1	7.5	7.5	12.0	0.5	466	-4	-3,495
	VAV Rooftop Unit	409/408 Economics	1	10.0	10.0	12.0	0.5	466	-5	-4,660
	Rooftop Unit	Aux Gym	1	25.0	25.0	11.2	0.5	466	-13	-12,482
	Rooftop Unit	Weight Room / Locker	1	25.0	25.0	11.2	0.5	466	-13	-12,482
	Rooftop Unit	Music Classrooms	1	12.5	12.5	12.0	0.5	466	-6	-5,825
	Rooftop Unit	Main Gym	1	25.0	25.0	11.2	0.5	466	-13	-12,482
	Rooftop Unit	Main Gym	1	25.0	25.0	11.2	0.5	466	-13	-12,482
	Rooftop Unit	Girls Locker Room	1	10.0	10.0	12.0	0.5	466	-5	-4,660
	Rooftop Unit	Boys Locker Room	1	10.0	10.0	12.0	0.5	466	-5	-4,660
	Rooftop Unit	Trainers Room	1	10.0	10.0	12.0	0.5	466	-5	-4,660

RTU - Heating Savings

BUILDING NAME	SYSTEM	Areas Served	Qty	Estimated Existing Efficiency	Efficiency Units	Baseline RTU Rated Input MBH	Baseline Plant Rated Input MBH (CAPYbi)
Ramapo High School	Rooftop Unit	Boys Locker Room	1	75.6%	%AFUE	400	400
	Rooftop Unit	Main Gym Right	1	75.6%	%AFUE	800	800
	Rooftop Unit	Main Gym Left	1	75.6%	%AFUE	800	800
	Rooftop Unit	Girls Locker Room	1	80.0%	%AFUE	400	400
	Rooftop Unit	Lower Gym South	1	87.0%	%AFUE	240	240
	Rooftop Unit	Lower Gym North	1	87.0%	%AFUE	240	240
	Rooftop Unit	Lower Gym Lower Level Lockers	1	87.0%	%AFUE	240	240
	UV/VRF	613D Team Room	1	87.0%	%AFUE	50	50
	UV/VRF	613 Team Room	1	87.0%	%AFUE	50	50
	ERU/VRF	613, 613, 613A	1	87.0%	%AFUE	50	50
Indian Hills High School	Rooftop Unit	Cafeteria	1	84.9%	%AFUE	1042	1,042
	Rooftop Unit	056 (Café Left)	1	84.9%	%AFUE	100	100
	Rooftop Unit	410B (Café Right)	1	84.9%	%AFUE	100	100
	VAV Rooftop Unit	409/408 Economics	1	84.9%	%AFUE	300	300
	Rooftop Unit	Aux Gym	1	78.3%	%AFUE	812	812
	Rooftop Unit	Weight Room / Locker	1	78.3%	%AFUE	812	812
	Rooftop Unit	Music Classrooms	1	78.3%	%AFUE	250	250
	Rooftop Unit	Main Gym	1	84.9%	%AFUE	800	800
	Rooftop Unit	Main Gym	1	84.9%	%AFUE	800	800
	Rooftop Unit	Girls Locker Room	1	84.9%	%AFUE	253	253
	Rooftop Unit	Boys Locker Room	1	84.9%	%AFUE	253	253
	Rooftop Unit	Trainers Room	1	84.9%	%AFUE	253	253

RTU - Heating Savings

BUILDING NAME	SYSTEM	Areas Served	Qty	Qualifying RTU Capacity MBH	Qualifying Plant Capacity (CAPYqi)	Qualifying RTU Efficiency	Efficiency Units	EFLH	Baseline Gas Use (Therms)	Proposed Gas Use (Therms)	Annual Gas Savings (Therms)
Ramapo High School	Rooftop Unit	Boys Locker Room	1	400	400	80.0%	%AFUE	901	4,770	4,505	265
	Rooftop Unit	Main Gym Right	1	800	800	80.0%	%AFUE	901	9,539	9,010	529
	Rooftop Unit	Main Gym Left	1	800	800	80.0%	%AFUE	901	9,539	9,010	529
	Rooftop Unit	Girls Locker Room	1	400	400	80.0%	%AFUE	901	4,505	4,505	-
	Rooftop Unit	Lower Gym South	1	240	240	87.0%	%AFUE	901	2,480	2,480	-
	Rooftop Unit	Lower Gym North	1	240	240	87.0%	%AFUE	901	2,480	2,480	-
	Rooftop Unit	Lower Gym Lower Level Lockers	1	240	240	87.0%	%AFUE	901	2,480	2,480	-
	UV/VRF	613D Team Room	1	50	50	87.0%	%AFUE	901	518	518	-
	UV/VRF	613 Team Room	1	50	50	87.0%	%AFUE	901	518	518	-
	ERU/VRF	613, 613, 613A	1	50	50	87.0%	%AFUE	901	518	518	-
Indian Hills High School	Rooftop Unit	Cafeteria	1	1042	1,042	80.0%	%AFUE	901	11,058	11,736	(677)
	Rooftop Unit	056 (Café Left)	1	100	100	80.0%	%AFUE	901	1,061	1,126	(65)
	Rooftop Unit	410B (Café Right)	1	100	100	80.0%	%AFUE	901	1,061	1,126	(65)
	VAV Rooftop Unit	409/408 Economics	1	300	300	84.9%	%AFUE	901	3,184	3,184	-
	Rooftop Unit	Aux Gym	1	812	812	80.0%	%AFUE	901	9,344	9,145	199
	Rooftop Unit	Weight Room / Locker	1	812	812	80.0%	%AFUE	901	9,344	9,145	199
	Rooftop Unit	Music Classrooms	1	250	250	80.0%	%AFUE	901	2,877	2,816	61
	Rooftop Unit	Main Gym	1	800	800	80.0%	%AFUE	901	8,490	9,010	(520)
	Rooftop Unit	Main Gym	1	800	800	80.0%	%AFUE	901	8,490	9,010	(520)
	Rooftop Unit	Girls Locker Room	1	253	253	85%	%AFUE	901	2,685	2,685	-
	Rooftop Unit	Boys Locker Room	1	253	253	85%	%AFUE	901	2,685	2,685	-
	Rooftop Unit	Trainers Room	1	253	253	85%	%AFUE	901	2,685	2,685	-

RTU/VRF - Total Savings							
BUILDING NAME	SYSTEM	Annual Electric Savings (kWh)	Total Electric Savings (kWh)	Annual Demand Savings (kW)	Total Demand Savings (kW)	Annual Gas Savings (Therms)	Total Gas Savings (Therms)
Ramapo High School	Rooftop Unit	(6,692)	(72,004)	(7)	(74)	265	1,324
Ramapo High School	Rooftop Unit	(11,449)		(13)		529	
Ramapo High School	Rooftop Unit	(11,449)		(13)		529	
Ramapo High School	Rooftop Unit	(6,990)		(8)		-	
Ramapo High School	Rooftop Unit	(9,017)		(10)		-	
Ramapo High School	Rooftop Unit	(9,017)		(10)		-	
Ramapo High School	Rooftop Unit	(4,542)		(5)		-	
Ramapo High School	UV/VRF	(2,134)		(2)		-	
Ramapo High School	UV/VRF	16		0		-	
Ramapo High School	ERU/VRF	(10,731)		(5)		-	
Indian Hills High School	Rooftop Unit	(6,290)	(84,502)	(7)	(94)	(677)	(1,389)
Indian Hills High School	Rooftop Unit	(3,316)		(4)		(65)	
Indian Hills High School	Rooftop Unit	(3,316)		(4)		(65)	
Indian Hills High School	VAV Rooftop Unit	(4,362)		(5)		-	
Indian Hills High School	Rooftop Unit	(12,385)		(13)		199	
Indian Hills High School	Rooftop Unit	(12,385)		(13)		199	
Indian Hills High School	Rooftop Unit	(5,794)		(6)		61	
Indian Hills High School	Rooftop Unit	(11,782)		(13)		(520)	
Indian Hills High School	Rooftop Unit	(11,782)		(13)		(520)	
Indian Hills High School	Rooftop Unit	(4,362)		(5)		-	
Indian Hills High School	Rooftop Unit	(4,362)		(5)		-	
Indian Hills High School	Rooftop Unit	(4,362)		(5)		-	

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
LF	Fixed	0.75	1
η_{base}	Fixed	ASHRAE 90.1-2016 Baseline Efficiency Table	ASHRAE
η_{prem}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
IF_{VFD}	Fixed	1.0 or 0.9	3
Efficiency - η_{ee}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
CF	Fixed	0.74	1
HRS	Fixed	Annual Operating Hours Table	1

NEMA ASHRAE 90.1-2016 Motor Efficiency Table – General Purpose Subtype I (Adapted from Table 10.8-1)

Motor Horsepower	1200 RPM (6 pole)		1800 RPM (4 pole)		3600 RPM (2 pole)	
	ODP	TEFC	ODP	TEFC	ODP	TEFC
1	.825	.825	.855	.855	.77	.77
1.5	.865	.875	.865	.865	.84	.84
2	.875	.885	.865	.865	.855	.855
3	.885	.895	.895	.895	.855	.865
5	.895	.895	.895	.895	.865	.885
7.5	.902	.91	.91	.917	.885	.895
10	.917	.91	.917	.917	.895	.902
15	.917	.917	.93	.924	.902	.91
20	.924	.917	.93	.930	.91	.91
25	.93	.93	.936	.936	.917	.917
30	.936	.93	.941	.936	.917	.917
40	.941	.941	.941	.941	.924	.924
50	.941	.941	.945	.945	.93	.93
60	.945	.945	.95	.950	.936	.936
75	.945	.945	.95	.954	.936	.936
100	.95	.95	.954	.954	.936	.941
125	.95	.95	.954	.954	.941	.95
150	.954	.958	.958	.958	.941	.95
200	.954	.958	.958	.962	.95	.954

Annual Operating Hours Table

Motor Horsepower	Operating Hours, HRS
1 to 5 HP	2,745
6 to 20 HP	3,391
21 to 50 HP	4,067
51 to 100 HP	5,329
101 to 200 HP	5,200

Algorithms

From application form calculate ΔkW where:

$$\Delta kW = 0.746 * HP * IF_{VFD} * (1/\eta_{base} - 1/\eta_{prem})$$

Demand Savings = (ΔkW) * CF

Energy Savings = (ΔkW)*HRS * LF

Definition of Variables

ΔkW = kW Savings at full load

HP = Rated horsepower of qualifying motor, from nameplate/manufacturer specs.

LF = Load Factor, percent of full load at typical operating condition

IF_{VFD} = VFD Interaction Factor, 1.0 without VFD, 0.9 with VFD

η_{base} = Efficiency of the baseline motor

η_{prem} = Efficiency of the energy-efficient motor

HRS = Annual operating hours

CF = Coincidence Factor

VFD Savings Factors

Application	ESF (kWh/Year-HP)	DSF (kW/HP)	Source
Supply Air Fan	2,033	0.286	1
Return Air Fan	1,788	0.297	1
CHW or CW Pump	1,633	0.185	1
HHW Pump	1,548	0.096	1
WSHP Pump	2,562	0.234	1
CT Fan	290	-0.025	2, 3
Boiler Feedwater Pump	1,588	0.498	2, 3

Definition of Variables

N = Number of units

Tons = Rated cooling capacity of unit.This value comes from ARI/AHRI or AHAM rating or manufacturer data.

EER_b = Energy Efficiency Ratio of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER should be used in place of EER.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

EER_q = Energy Efficiency Ratio of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 (5.4 tons) BtuH, SEER should be used in place of EER.

COP_q = Coefficient of Performance of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value is based on existing measured usage and determined as the average number of operating hours during the peak window period.

$EFLH_{c\ or\ h}$ = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off-peak periods.

Summary of Inputs

HVAC and Heat Pumps

Component	Type	Value	Source
Tons	Variable	Rated Capacity, Tons	Application
EER_b	Variable	See Table below	1
EER_q	Variable	ARI/AHRI or AHAM Values	Application
CF	Fixed	50%	2
$EFLH_{(c\ or\ h)}$	Variable	See Tables below	3

HVAC Baseline Efficiencies Table – New Construction/EUL/RoF

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2016
Unitary HVAC/Split Systems and Single Package, Air Cooled	
<=5.4 tons, split	14 SEER
<=5.4 tons, single	14 SEER
>5.4 to 11.25 tons	11.0 EER, 12.7 IEER
>11.25 to 20 tons	10.8 EER, 12.2 IEER
> 21 to 63 tons	9.8 EER, 11.4 IEER
>63 Tons	9.5 EER, 11.0 IEER
Air Cooled Heat Pump Systems, Split System and Single Package	
<=5.4 tons, split	14 SEER, 8.2 HSPF
<=5.4 tons, single	14 SEER, 8.0 HSPF
>5.4 to 11.25 tons	10.8 EER, 12 IEER, 3.3 heating COP
>11.25 to 20 tons	10.4 EER, 11.4 IEER, 3.2 heating COP
>= 21	9.3 EER, 10.4 IEER, 3.2 heating COP

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2016
Water Source Heat Pumps (water to air, water loop)	
<=1.4 tons	12.2 EER, 4.3 heating COP
>1.4 to 5.4 tons	13.0 EER, 4.3 heating COP
>5.4 to 11.25 tons	13.0 EER, 4.3 heating COP
Ground Water Source Heat Pumps <=11.25 tons	18.0 EER, 3.7 heating COP
Ground Source Heat Pumps (brine to air, ground loop) <=11.25 tons	14.1 EER, 3.2 heating COP
Package Terminal Air Conditioners[57]	14.0 – (0.300 * Cap/1,000), EER
Package Terminal Heat Pumps	14.0 – (0.300 * Cap/1,000), EER 3.7 – (0.052 * Cap/1,000), heating COP
Single Package Vertical Air Conditioners	
<=5.4 tons	10.0 EER
>5.4 to 11.25 tons	10.0 EER
>11.25 to 20 tons	10.0 EER
Single Package Vertical Heat Pumps	
<=5.4 tons	10.0 EER, 3.0 heating COP
>5.4 to 11.25 tons	10.0 EER, 3.0 heating COP
>11.25 to 20 tons	10.0 EER, 3.0 heating COP

Algorithms

Air Conditioning Algorithms:

Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * (1/EER_b-1/EER_q) * $EFLH_c$

Peak Demand Savings (kW) = N * Tons * 12 kBtuh/Ton * (1/EER_b-1/EER_q) * CF

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

Algorithms

Fuel Savings (MMBtu/yr) = Cap_{in} * $EFLH_h$ * ((Eff_q/Eff_b)-1) / 1000 kBtu/MMBtu

Definition of Variables

Cap_{in} = Input capacity of qualifying unit in kBtu/hr

$EFLH_h$ = The Equivalent Full Load Hours of operation for the average unit during the heating season in hours

Eff_b = Furnace Baseline Efficiency

Eff_q = Furnace Proposed Efficiency

1000 = Conversion from kBtu to MMBtu

Summary of Inputs

Prescriptive Furnaces

Component	Type	Value	Source
Cap_{in}	Variable		Application
$EFLH_h$	Fixed	See Table Below	1
Eff_q	Variable		Application
Eff_b	Fixed	See Table Below	2

$EFLH_h$ Table

Facility Type	Heating EFLH
Assembly	603
Auto repair	1910
Dormitory	465
Hospital	3366
Light industrial	714
Lodging – Hotel	1077
Lodging – Motel	619
Office – large	2034
Office – small	431
Other	681
Religious worship	722

Facility Type	Heating EFLH
Restaurant – fast food	813
Restaurant – full service	821
Retail – big box	191
Retail – Grocery	191
Retail – small	545
Retail – large	2101
School – Community college	1431
School – postsecondary	1191
School – primary	840
School – secondary	901
Warehouse	452

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Heating	757	723	503
High-rise, Heating	526	395	219

Baseline Furnace Efficiencies (Eff_b)

Furnace Type	Size Category (kBtu input)	Standard 90.1-2016
Gas Fired	< 225 ≥ 225	78% AFUE or 80% Et 80% Et
Oil Fired	< 225 ≥ 225	78% AFUE 81% Et

ECM 20 – Field Lighting Fixture Replacement

RAMAPO INDIAN HILLS RHSD

- ✓ ECM evaluated but not included
- ✓ ECM included in the project

ECM #	ECM DESCRIPTION	Ramapo High School	Indian Hills High School
20	Field Lighting Fixture Replacement	✓	✓

Outdoor field lighting are types of site light fixtures that are commonly used to illuminate large areas for sporting events or other large outdoor events and activities, such as concerts. Sports light fixtures are typically mounted on poles 40 to 100 feet tall, with between 1-12 fixtures mounted on each pole. This type of outdoor lighting is often used by schools, colleges and universities, municipalities, amateur sports clubs, and professional sports franchises.

Common (HID) lamp wattages used for conventional sports lighting fixtures range from 400 watts to 2,000 watts. The higher the wattage, the higher the light output. The function of the area being illuminated, combined with the quantity, spacing, and mounting height of the field light fixtures plays a role in the existing wattages utilized. A few 1000w or 2000w metal halide sports light lamps (very common wattages for existing outdoor sports lighting) can cost up to $6,300 to $12,500 to operate per year, in electricity costs alone.

Maintenance costs are often a big concern for those managing lights. In addition to the potential lamp lifetime concerns, sports field fixtures can easily cause interference with the day-to-day activities of teams or employees when changing out a lamp or a ballast. It can cost up to $2,000 in labor and material to maintain a single exterior HID sports field fixture over the course of three years.

Existing Conditions

Existing Field Lighting at Ramapo HS

Ramapo High School

- Existing Field Lighting evaluated for replacement located at Ramapo High School Football Field
- Four (4) total fixtures located on Four (4) steel poles
- Existing lighting system is approxemently 70kW.

Indian Hills High School

- Existing Field Lighting evaluated for replacement located at Indian Hills High School Football Field
- Four (4) total fixtures located on Four (4) steel poles
- Existing lighting system is approxemently 96kW.

Scope of Work

Both district high schools are evaluated for LED Football Field Lighting fixture replacements at 30 Footcandles. The following work is being done at each school:

Ramapo High School and Indian Hills High School

- Factory wired pole top luminaire assemblies

- Factory wired and tested remote electrical component enclosures
- Pole length, factory assembled wire harnesses
- Mounting hardware for pole top luminaire assemblies and electrical components enclosures
- Disconnects
- Includes demo of existing lighting, supply, and installation of lighting system, and reconnecting to owners existing electrical system by a licensed contractor
- Assumes the existing structures, electrical wiring, and electrical service can be reused
- Proposed Lighting System is 36.80kW for 30fc

LED Fixture Replacement Scope of Work			
BUILDING	CATEGORY	NOTES	QUANTITY
Ramapo High School	LED Fixture (Field Lighting)	Musco Lighting System 30FC	4
		Control Cabinet	
Indian Hills High School	LED Fixture (Field Lighting)	Musco Lighting System 30FC	4
		Control Cabinet	

ECM Calculations

BPU Protocols were used to calculate Field Lighting Fixture Replacement. See calculations below.

CALCULATED SAVINGS

LED Fixture Replacement Savings												
BUILDING	SPACE	kW_b	kW_q	ΔkW	CF	Hours per Year	HVACd	HVACe	HVACg	Peak Demand Savings (kW)	Energy Savings (kWh)	Fuel Savings (therms)
Ramapo High School	EXTERIOR	70.00	36.80	33.20	0.5	420	0	0	0	16.60	13,944	0
Indian Hills High School	EXTERIOR	96.00	36.80	59.20	0.5	420	0	0	0	29.60	24,864	0

Algorithms

$$DkW = (\#\ of\ replaced\ fixtures) * (Watts_b) - (\#\ of\ fixtures\ installed) * (Watts_q) = (LPD_b - LPD_q) * (SF)$$

$$\text{Energy Savings}\left(\frac{\text{kWh}}{\text{yr}}\right) = (\Delta\text{kW}) * (\text{Hrs}) * (1 + HVAC_e)$$

$$\text{Peak Demand Savings (kW)} = (\Delta\text{kW}) * (\text{CF}) * (1 + HVAC_d)$$

$$\text{Fuel Savings}\left(\frac{\text{MMBtu}}{\text{yr}}\right) = (\Delta\text{kW}) * (\text{Hrs}) * (\text{HVAC}_g)$$

Definition of Variables

ΔkW	= Change in connected load from baseline to efficient lighting
$Watts_{b,q}$	= Wattage of existing baseline and qualifying equipment
LPD_b	= Baseline lighting power density in Watt per square foot of space floor area
LPD_q	= Lighting power density of qualified fixtures, equal to the sum of installed fixture wattage divided by floor area of the space where the fixtures are installed.
SF	= Space floor area, in square feet
CF	= Coincidence factor
Hrs	= Annual operating hours
$HVAC_d$	= HVAC Interactive Factor for peak demand savings
$HVAC_e$	= HVAC Interactive Factor for annual energy savings
$HVAC_g$	= HVAC Interactive Factor for annual energy savings

Summary of Inputs

Pay for Performance Existing Buildings *Partner Guidelines Version 4.5*

- Typical exterior lighting fixtures should be modeled as lit twelve (12) hours per day on average.

Lighting Verification Performance Lighting

Component	Type	Value	Source
$Watts_{b,q}$	Variable	See NGrid Fixture Wattage Table Fixture counts and types, space type, floor area from customer application.	1
SF	Variable	From Customer Application	Application
CF	Fixed	See Table by Building Type	4
Hrs	Fixed	See Table by Building Type	4
$HVAC_d$	Fixed	See Table by Building Type	3, 5
$HVAC_e$	Fixed	See Table by Building Type	3, 5
$HVAC_g$	Fixed	See Table by Building Type	6
LPD_b	Variable	Lighting Power Density for, W/SF	2
LPD_q	Variable	Lighting Power Density, W/SF	Application

Hours of Operation and Coincidence Factor by Building Type

Building Type	Sector	CF	Hours
Grocery	Large Commercial/Industrial & Small Commercial	0.96	7,134
Medical - Clinic	Large Commercial/Industrial & Small Commercial	0.8	3,909
Medical - Hospital	Large Commercial/Industrial & Small Commercial	0.8	8,760[54]
Office	Large Commercial/Industrial	0.7	2,969
	Small Commercial	0.67	2,950
Other	Large Commercial/Industrial & Small Commercial	0.66	4,573
Retail	Large Commercial/Industrial	0.96	4,920
	Small Commercial	0.86	4,926
School	Large Commercial/Industrial & Small Commercial	0.50	2,575
Warehouse/ Industrial	Large Commercial/Industrial	0.7	4,116
	Small Commercial	0.68	3,799

Building Type	Sector	CF	Hours
Multifamily – Common Areas[55]	Multifamily	0.86	5,950
Multifamily – In-Unit[36]	Multifamily	0.59	679
Multifamily – Exterior[36]	Multifamily	0.00	3,338

HVAC Interactive Effects

Building Type	Demand Waste Heat Factor ($HVAC_d$)		Annual Energy Waste Heat Factor by Cooling/Heating Type ($HVAC_e$)			
	AC (Utility)	AC (PJM)	AC/ NonElec	AC/ ElecRes	Heat Pump	NoAC/ ElecRes
Office	0.35	0.32	0.10	-0.15	-0.06	-0.25
Retail	0.27	0.26	0.06	-0.17	-0.05	-0.23
Education	0.44	0.44	0.10	-0.19	-0.04	-0.29
Warehouse	0.22	0.23	0.02	-0.25	-0.11	-0.27
Other[56]	0.34	0.32	0.08	-0.18	-0.07	-0.26

Interactive Factor (HVACg) for Annual Fuel Savings

Project Type	Fuel Type	Impact (MMBtu/ΔkWh)
Large Retrofit (> 200 kW)	C&I Gas Heat	-0.00023
Large Retrofit (> 200 kW)	Oil	-0.00046
Small Retrofit (≤ 200 kW)	Gas Heat	-0.001075
Small Retrofit (> 200 kW)	Oil Heat	-0.000120

Sources

1. Device Codes and Rated Lighting System Wattage Table Retrofit Program, National Grid, January 13, 2015. https://www1.nationalgridus.com/files/AddedPDF/POA/RILightingRetrofit1.pdf

ENERGY SAVINGS PLAN

SECTION 4 – FINANCIAL ANALYSIS

Form V – ESCO Construction and Service Fees

FORM V		
ESCO's ENERGY SAVINGS PLAN (ESP): ESCOs PROPOSED FINAL PROJECT COST FORM RAMAPO INDIAN HILLS RHSD ENERGY SAVING IMPROVEMENT PROGRAM		
ESCO Name: DCO Energy PROPOSED CONSTRUCTION FEES:		
Fee Category	Fees [1] Dollar ($) Value	Percentage of Hard Costs
Estimated Value of Hard Costs [2]	$ 4,484,172	
ECM Contingency	$ 252,884	
PSE&G Engineering Costs	$ 79,221	
Total Value of Hard Costs	$ 4,816,277	
Project Service Fees		
Investment Grade Energy Audit	$ 96,326	2.00%
Design Engineering Fees	$ 60,203	1.25%
Construction Management & Project Administration	$ 361,221	7.50%
System Commissioning	$ 36,122	0.75%
Equipment Initial Training Fees	$ 36,122	0.75%
ESCO Overhead	$ 240,814	5.00%
ESCO Profit	$ 192,651	4.00%
Project Service Fees Subtotal	$ 589,994	12.25%
TOTAL FINANCED PROJECT COSTS:	$ 5,839,736	21.25%

PROPOSED ANNUAL SERVICE FEES		
First Year Annual Service Fees	Fees [1] Dollar ($) Value	Percentage of Hard Costs
SAVINGS GUARANTEE *(OPTION)*	$0	0.00%
Measurement & Verification *(Associated w/ Savings Guarantee Option)*	$25,526	0.53%
ENERGY STAR Services *(optional)*	$0	0.00%
Post Construction Services *(if applicable)*	$38,530	0.80%
Performance Monitoring	w/ M&V	0.00%
On-going Training Services	w/ M&V	0.00%
Verification Reports	w/ M&V	0.00%
TOTAL FIRST YEAR ANNUAL SERVICES	$0	0.00%

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

Form VI – Project Cash Flow Analysis

FORM VI

ESCO's ENERGY SAVINGS PLAN (ESP):
ESCO's ANNUAL CASH FLOW ANALYSIS FORM
RAMAPO INDIAN HILLS RHSD - ENERGY SAVING IMPROVEMENT PROGRAM

ESCO Name: DCO Energy

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 per year and
1. Term of Agreement: 15 Years
2. Construction Period (2) (months): 12 Months
3. Cash Flow Analysis Format:

Miscellaneous Costs Financed:	
LAN Associates	$409,384
Cost of Issuance	$40,000
Total	$449,384

Project Cost[1]:	**$5,839,736**
Capital Contribution:	**$0**
Miscellaneous Costs Financed:	**$449,384**
Financed Amount:	**$5,357,761**

Interest Rate:	**3.50%**
Effective Rate:	**3.01%**

Year	Annual Energy Savings	Solar Savings	Annual Operational Savings	Energy Rebates / Incentives[3]	Total Annual Savings	Annual Project Costs	Net Cash-Flow to Client	Cumulative Cash Flow
Installation	$ 125,378		$ -	$ (745,087)	$ 125,378	$ -	$ 125,378	$ 125,378
Year 1	$ 231,077	$ 169,475	$ 33,208	$ (186,272)	$ 433,760	$ (431,360)	$ 2,400	$ 127,778
Year 2	$ 236,224	$ 172,670	$ 33,208	$ -	$ 442,101	$ (439,701)	$ 2,400	$ 130,178
Year 3	$ 241,486	$ 175,905	$ 18,285	$ -	$ 435,676	$ (433,276)	$ 2,400	$ 132,578
Year 4	$ 246,866	$ 179,182	$ 18,285	$ -	$ 444,333	$ (441,933)	$ 2,400	$ 134,978
Year 5	$ 252,368	$ 182,500	$ 18,285		$ 453,152	$ (450,752)	$ 2,400	$ 137,378
Year 6	$ 257,993	$ 185,859			$ 443,852	$ (441,452)	$ 2,400	$ 139,778
Year 7	$ 263,745	$ 189,262			$ 453,006	$ (450,606)	$ 2,400	$ 142,178
Year 8	$ 269,626	$ 192,707			$ 462,333	$ (459,933)	$ 2,400	$ 144,578
Year 9	$ 275,639	$ 196,196			$ 471,835	$ (469,435)	$ 2,400	$ 146,978
Year 10	$ 281,788	$ 199,728			$ 481,516	$ (479,116)	$ 2,400	$ 149,378
Year 11	$ 288,075	$ 203,305			$ 491,380	$ (488,980)	$ 2,400	$ 151,778
Year 12	$ 294,503	$ 206,928			$ 501,431	$ (499,031)	$ 2,400	$ 154,178
Year 13	$ 301,076	$ 210,596			$ 511,672	$ (509,272)	$ 2,400	$ 156,578
Year 14	$ 307,797	$ 214,310			$ 522,107	$ (519,707)	$ 2,400	$ 158,978
Year 15	$ 314,669	$ 218,070			$ 532,739	$ (530,339)	$ 2,400	$ 161,378
Totals	$ 4,188,309	$ 2,896,691	$ 121,272	$ (931,359)	$ 7,206,272	$ (7,044,894)	$ 161,378	

NOTES:
(1) Includes: Hard costs and project service fees defined in ESCO's PROPOSED "FORM V"
(2) No payments are made by RIHRHSD during the construction period.
(3) As of July 1, 2021, all of former NJ Clean Energy Program incentive programs transitioned over to the investor-owned gas and electric utility companies. Subsequently, the BPU is requiring that all ESIP projects consult with the DCA and follow all DCA guidance regarding the procurement of all subcontractors.

Utility Inflation Details

Per Form VI, the annual inflation rate is 2.2% for electric and 2.4% for natural gas. The solar PPA rate escalates at 1.25% per year – see ECM 14 in Section 3 for more details. Water savings do not escalate.

Utility Inflation Worksheet				
Year	NET ANNUAL ELECTRIC COST SAVINGS (EXCLUDING SOLAR PPA SAVINGS)	ANNUAL NATURAL GAS COST SAVINGS	Net Solar Savings	ANNUAL Water & Sewer (Gal) COST SAVINGS
1	$176,860.92	$52,312.22	$169,474.88	$1,903.95
2	$180,751.86	$53,567.72	$172,669.84	$1,903.95
3	$184,728.40	$54,853.34	$175,905.28	$1,903.95
4	$188,792.42	$56,169.82	$179,181.68	$1,903.95
5	$192,945.86	$57,517.90	$182,499.55	$1,903.95
6	$197,190.66	$58,898.33	$185,859.36	$1,903.95
7	$201,528.86	$60,311.89	$189,261.63	$1,903.95
8	$205,962.49	$61,759.37	$192,706.85	$1,903.95
9	$210,493.67	$63,241.60	$196,195.55	$1,903.95
10	$215,124.53	$64,759.40	$199,728.24	$1,903.95
11	$219,857.27	$66,313.62	$203,305.45	$1,903.95
12	$224,694.13	$67,905.15	$206,927.70	$1,903.95
13	$229,637.40	$69,534.87	$210,595.54	$1,903.95
14	$234,689.42	$71,203.71	$214,309.50	$1,903.95
15	$239,852.59	$72,912.60	$218,070.15	$1,903.95

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ENERGY SAVINGS PLAN

SECTION 5 – RISK, DESIGN, & COMPLIANCE

Assessment of Risks, Design & Compliance Issues

Moving from a conceptual design to engineered documents DCO has identified areas of the project that could change during the detailed design. The table below represents potential conceptual areas of concern that will need to be investigated further with a corresponding party responsible for the compliance of each item.

Issue	Category	Responsible Party
Alteration of expected Maintenance and Operational Savings	Risk	Ramapo Indian Hills Regional High School District
Disposition of Abandoned Equipment (Steam Piping, Condensate Piping, Oil Tanks, etc.)	Risk	Ramapo Indian Hills Regional High School District
New Natural Gas Distribution	Risk	Ramapo Indian Hills Regional High School District
Integrity of re-used Infrastructure	Risk	Ramapo Indian Hills Regional High School District
Life Safety System Coordination	Risk	Ramapo Indian Hills Regional High School District
Coordination with Ramapo Indian Hills Regional High School District Information Technology Department	Risk	Ramapo Indian Hills Regional High School District
Ventilation Compliance with Code	Compliance	Consulting Engineer
Temperature, Humidity and Air Change Compliance with Code	Compliance	Consulting Engineer
Boiler Capacity and Turndown	Design	Consulting Engineer
Natural Gas Regulator Compliance with Code	Compliance	Consulting Engineer
Undocumented Underground Utilities	Risk	Consulting Engineer
Code Compliance of Existing Electrical Infrastructure	Compliance	Consulting Engineer

Lighting Levels	Compliance	Consulting Engineer
Design Light Consortium rating for bulbs	Compliance	Consulting Engineer
Underwriters Laboratory Testing for retrofitted LED Lighting Systems	Compliance	Consulting Engineer
Lighting Retrofits within hard ceilings for fixtures and occupancy sensors	Risk	Consulting Engineer
Street/Parking Lot Pole Structural Integrity	Risk	Consulting Engineer
Unrealized Energy Savings 1. Energy Modeling 2. Performance Monitoring 3. Capacity of Equipment 4. Efficiency of Equipment 5. Run Hours of Equipment	Risk	DCO/ Consulting Engineer 1. DCO 2. DCO 3. Consulting Engineer / Basis of Design Vendor 4. Consulting Engineer / Basis of Design Vendor 5. Ramapo Indian Hills Regional High School District
Existing Plumbing Infrastructure with New Low Flow Devices	Design	Consulting Engineer
Adaptation to New RTUs (Curb, Electric, Ductwork, Condensate)	Design	Consulting Engineer / Basis of Design Manufacture
Structural Loads for Rooftop Equipment Replacement	Design	Consulting Engineer
Transformer Loading	Risk	Consulting Engineer
Site Work for Equipment	Design	Consulting Engineer
Condition of Roof Under Units	Risk	Consulting Engineer
Adequate Crane Lifts & Clearances	Design	Consulting Engineer / Rigger
Physical Space Constraints and Clearance for Equipment Replacement	Design	Consulting Engineer

Refrigerant Reclaim / Refrigerant Disposal	Compliance	Contractor
Existing Tie in Locations	Design	Consulting Engineer
Schedule Oversight	Risk	DCO Energy
Impact of Boiler Flue	Design	Consulting Engineer
Impact of Space Usage During Construction	Risk	Consulting Engineer & Ramapo Indian Hills Regional High School District
Scope changes relating to requests by Authorities Having Jurisdiction.	Risk	Ramapo Indian Hills Regional High School District (via contingency)
Department of Environmental Protection Permitting	Risk	Consulting Engineer
Modifications of Energy Saving Control Sequences and Setpoints impacting Energy Savings and Incentives	Risk	Ramapo Indian Hills Regional High School District
Post Construction Calibration of Sensors, Meters, & Safety Devices	Risk	Ramapo Indian Hills Regional High School District
Adequate time and access for bidding contractor site surveys	Risk	Ramapo Indian Hills Regional High School District
Utility Interconnection approval for the CHP Unit	Risk	Contractor

Measurement & Verification (M&V) Plan

Our approach to M&V of energy savings aligns with the International Performance Measurement & Verification Protocol. More detailed information may be found below. It's most cost-effective to perform M&V using the least costly option that still adequately documents system performance and permits analysis of savings. This approach lowers the total cost of the program leaving more dollars available to perform more facility improvements. Depending upon which ECMs are implemented by Ramapo Indian Hills Regional High School District, the M&V plan proposed by DCO would incorporate one or more of the following options which outlines the four most common approaches for M&V:

Option A – Retrofit Isolation with Key Parameter Measurement	This option is based on a combination of measured and estimated factors when variations in factors are not expected. Measurements are spot or short-term and are taken at the component or system level, both in the baseline and post-installation cases. Measurements should include the key performance parameter(s) which define the energy use of the ECM. Estimated factors are supported by historical or manufacturer's data. Savings are determined by means of engineering calculations of baseline and post-installation energy use based on measured and estimated values.	Direct measurements and estimated values, engineering calculations and/or component or system models often developed through regression analysis. Adjustments to models are not typically required.
Option B – Retrofit Isolation with Parameter Measurement	This option is based on periodic or continuous measurements of energy use taken at the component or system level when variations in factors are expected. Energy or proxies of energy use are measured continuously. Periodic spot or short-term measurements may suffice when variations in factors are not expected. Savings are determined form analysis of baseline and reporting period energy use of proxies of energy use.	Direct measurements, engineering calculations, and/or component or system models often developed through regression analysis. Adjustments to models may be required.
Option C – Utility Data Analysis	This option is based on long-term, continuous, whole-building utility meter, facility level, or sub-meter energy (or water) data. Savings are determined from analysis of baseline and reporting period energy data. Typically, regression analysis is conducted to correlate with and adjust energy use to independent variables such as weather, but simple comparisons may also be used.	Based on regression analysis of utility meter data to account for factors that drive energy use. Adjustments to models are typically required.
Option D – Calibrated	Computer simulation software is used to model energy performance of a whole-facility (or sub-facility). Models must be calibrated with actual hourly or monthly billing data from the facility. Implementation of simulation modeling requires	Based on computer simulation model calibrated with whole-building or end-use

Computer Simulation	engineering expertise. Inputs to the model include facility characteristics; performance specifications of new and existing equipment or systems; engineering estimates, spot-, short-term, or long-term measurements of system components; and long-term whole-building utility meter data. After the model has been calibrated, savings are determined by comparing a simulation of the baseline with either a simulation of the performance period or actual utility data	metered data or both. Adjustments to models are required.

Each of the options can be used for a wide array of energy efficiency upgrades and each has different costs and complexities associated with it. When selecting an M&V approach, the following general rule of thumb can be applied:

OPTION A

- When magnitude of savings is low for the entire project or a portion of the project
- The risk for not achieving savings is low

OPTION B

- For simple equipment replacement projects
- When energy savings values per individual measure are desired
- When interactive effects are to be ignored or are estimated using estimating methods that do not involve long term measurements
- When sub-meters already exist that record the energy use of subsystems under consideration

OPTION C

- For complex equipment replacement and controls projects
- When predicted energy savings are in excess of 10 to 20 percent as compared with the record energy use
- When energy savings per individual measure are not desired
- When interactive effects are to be included
- When the independent variables that affect energy, use are complex and excessively difficult or expensive

OPTION D

- When new construction projects are involved
- When energy savings values per measure are desired
- When Option C tools cannot cost effectively evaluate particular measures or their interactions with the building when complex baseline adjustments are anticipated

DCO will perform measurement and verification of the energy unit savings at the conclusion of each month in the first year of the energy units guarantee. After the first year, M&V will be performed and presented within 30 days of year end. Ramapo Indian Hills Regional High School District will work with DCO to provide necessary information and provide access to any buildings to allow DCO to properly verify and measure energy savings. DCO's energy guarantee will be based on units of energy saved as determined from the baseline provided in the RFP, or adjusted baseline if original baseline is determined by both parties to be inaccurate.

Adjustments to the baseline and associated savings will be taken for weather, hours of operation, building usage, utility rate increases, code or statute changes, requirements listed in Table 1, and any other actions that adversely affect the savings beyond the control of DCO. Any savings discrepancies will be resolved to the satisfaction of both the Ramapo Indian Hills Regional High School District and DCO in a timely manner.

As part of the optional energy guarantee, DCO uses weather normalization procedures to correct for the effect of weather variance on energy savings in subsequent years. Baseline energy and weather data are used to establish an algorithm to predict how the baseline building uses energy as a function of weather. The algorithm is then applied to subsequent years to correct for the impact weather may have on future building energy use. The weather normalization procedure and algorithms will be covered in detail as part of the optional energy guarantee contract provided to Ramapo Indian Hills Regional High School District.

Maintenance Plan

Owner Tasks and Responsibilities:

As a general statement, Ramapo Indian Hills Regional High School District or its 3rd party service providers shall be responsible for providing ongoing maintenance through the duration of the M&V period. DCO will review operational procedures and schedules associated with such things as the building automation/control upgrades as well as the manufacturers' published requirements for all installed equipment be it: quarterly, semi-annually or annually. In most cases, Ramapo Indian Hills Regional High School District is already aware of or self-implementing similar maintenance practices on campus or has contracted a 3rd party for such services. Failure to properly maintain the equipment may cause energy savings goals to fall short.

Specific Areas of Consideration:

In order to sustain energy savings Ramapo Indian Hills Regional High School District's Staff will be required to implement new maintenance tasks and even modify existing policies and practices. Outlined are two examples of specific instances.

Example 1. Advanced Building Operations Programming:

Ramapo Indian Hills Regional High School District will be given specific training on the changes and advancements in the environmental operations and energy savings strategies. Ramapo Indian Hills Regional High School District will be responsible for following the agreed upon guidelines associated with programmed schedules and any use of override functions.

Example 2. Verification of Proper Operations: Mechanical Equipment

Ramapo Indian Hills Regional High School District will be required to assure that proper mechanical maintenance continues to be implemented on its mechanical equipment. Example: outside air dampers will require proper operation with the appropriate seals in order to maintain ECM(s) such as demand ventilation. DCO will periodically spot check system operations to verify the Owner or its 3rd party representative is implementing proper maintenance. Any deficiencies that may be identified will be brought to Ramapo Indian Hills Regional High School District's attention for correction.

ENERGY SAVINGS PLAN

SECTION 6 – OPERATION & MAINTENANCE

It is critical to the success of achieving continued energy savings that Ramapo Indian Hills Regional High School District develop and implement an Operation and Maintenance Plan. In this section are some recommendations for Ramapo Indian Hills Regional High School District and/or 3rd party maintenance contractors.

Air Handling Units

Comprehensive Annual Inspection

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.
3. General Assembly
   a) Inspect the unit for cleanliness.
   b) Inspect the fan wheel and shaft for wear and clearance.
   c) Check the sheaves and pulleys for wear and alignment.
   d) Check the belts for tension, wear, cracks, and glazing.
   e) Verify tight bolts, set screws, and locking collars.
   f) Check dampers for wear, security and linkage adjustment.
   g) Verify clean condensate pan.
   h) Verify proper operation of the condensate drain.
   i) Verify clean air filters.
   j) Verify clean coils.
   k) Verify proper operation of the spray pump, if applicable.
   l) Verify smooth fan operation.
   m) Log operating conditions after system has stabilized.
   n) Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.
4. Lubrication
   a) Lubricate the fan shaft bearings, if applicable.
   b) Lubricate the motor bearings, if applicable.
5. Controls and Safeties
   a) Test the operation of the low temperature safety device, if applicable.
   b) Test the operation of the high static pressure safety device, if applicable.
   c) Test the operation of the low static pressure safety device, if applicable.
   d) Check the thermal cutout on electric heaters, if applicable.
   e) Check the step controller, if applicable.

f) Check and record supply air and control air pressure, if applicable.
g) Verify the operation of the control system and dampers while the fan is operating.

6. Motor and Starter
   a) Clean the starter and cabinet.
   b) Inspect the wiring and connections for tightness and signs of overheating and discoloration. This includes wiring to the electric heat, if applicable.
   c) Check the condition of the contacts for wear and pitting.
   d) Check the contactors for free and smooth operation.
   e) Meg the motor and record readings.

Heating Inspection

1. Gas Heat Option
   a) Visually inspect the heat exchanger.
   b) Inspect the combustion air blower fan, and clean, if required.
   c) Lubricate the combustion air blower fan motor, if applicable.
   d) Verify the operation of the combustion air flow-proving device.
   e) Test the operation of the high gas pressure safety device, if applicable. Calibrate, if necessary.
   f) Test the operation of the low gas pressure safety device, if applicable. Calibrate, if necessary.
   g) Verify the operation of the flame detection device.
   h) Test the operation of the high temperature limit switch.
   i) Verify the integrity of the flue system.
   j) Verify the operation of the operating controls.
   k) Verify the burner sequence of operation.
   l) Verify proper gas pressure to the unit and/or at the manifold, if applicable.
   m) Perform combustion test. Make adjustments as necessary.
2. Electric Heat Option
   a) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   b) Check and calibrate operating and safety controls, if applicable.
   c) Verify the operation of the heating elements.
   d) Check voltage and amperage and compare readings with the watt rating on the heater.
3. Hot Water / Steam Heat Option
   a) Inspect control valves and traps.
   b) Check and calibrate all operating and safety controls.
   c) Verify the operation of the heating coils.
   d) Verify the operation of the unit low temperature safety device.

Scheduled Running Inspection

1. Check the general condition of the fan.
2. Verify smooth fan operation.
3. Check and record supply and control air pressure, if applicable.
4. Verify the operation of the control system.
5. Log the operating conditions after the system has stabilized.
6. Review operating procedures with operating personnel.
7. Provide a written report of completed work, operating log, and indicate uncorrected deficiencies detected.

Oil Sample/Spectrographic Analysis

1. Pull oil sample for spectrographic analysis

Refrigerant Sample/Analysis

1. Pull refrigerant sample for spectrographic analysis for contaminants (oil, water, and acid), using approved containers

Boilers

Comprehensive Annual Inspection

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.
3. General Assembly
   a) Secure and drain the boiler.
   b) Open the fire and water side for cleaning and inspection.
   c) Check heating surfaces and water side for corrosion, pitting, scale, blisters, bulges, and soot.
   d) Inspect refractory.
   e) Clean fire inspection glass.
   f) Check blow-down valve packing, and lubricate.
   g) Check and test boiler blow-down valve.

h) Perform hydrostatic test, if required.
i) Verify proper operation of the level float.
j) Gas Train Burner Assembly
    1. Check the gas train isolation valves for leaks.
    2. Check the gas supply piping for leaks.
    3. Check the gas pilot solenoid valve for wear and leaks.
    4. Check the main gas and the pilot gas regulators for wear and leaks.
    5. Test the low gas pressure switch. Calibrate and record setting.
    6. Test the high gas pressure switch. Calibrate and record setting.
    7. Verify the operation of the burner fan air flow switch.
    8. Inspect and clean the burner assembly.
    9. Inspect and clean the pilot igniter assembly.
    10. Inspect and clean the burner fan.
    11. Run the fan and check for vibration.
    12. Inspect the flue and flue damper.
    13. Burner Control Panel:
        a) Inspect the panel for cleanliness.
        b) Inspect wiring and connections for tightness and signs of overheating and discoloration.
k) Clean burner fan wheel and air dampers. Check fan for vibration.
l) Verify tightness on linkage set screws.
m) Check gas valves for leakage (where test cocks are provided).
n) Verify proper operation of the feed water pump.
o) Verify proper operation of the feed water treating equipment.

4. Controls and Safeties
    a) Disassemble and inspect low water cutoff safety device.
    b) Reassemble boiler low water cutoff safety device with new gaskets.
    c) Clean contacts in program timer, if applicable.
    d) Check the operation of the low water cutoff safety device and feed controls.
    e) Verify the setting and test the operation of the operating and limit controls.
    f) Verify the operation of the water level control.

Startup/Checkout Procedure

1. Verify proper water level in the boiler
2. Test the safety/relief valve after startup (full pressure test).
3. Clean or replace fuel filters.

4. Clean fuel nozzles.
5. Inspect clean, and functionally test the flame scanner and flame safeguard relay.
6. Clean and adjust the ignition electrode.
7. Replace the vacuum tube in the flame safeguard control, if applicable.
8. Perform pilot turn down test.
9. Verify proper steam pressure.
10. Perform combustion test and adjust the burner for maximum efficiency.
11. Test the following items:
    a) Firing rate
    b) Fuel/air ratio
    c) CO_2
    d) CO
    e) NOX
    f) Perform smoke test.
12. Review operating procedures
13. Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

Mid-Season Running Inspection

1. Check the general condition of the unit.
2. Inspect the burner.
3. Adjust the burner controls to obtain proper combustion.
4. Check the operation of the pressure relief valve.
5. Check the operation of the low water cutoff and feed controls.
6. Check the setting and test the operation of the operating and limit controls.
7. Check the operation of the modulating motor.
8. Lift the safety/relief valves with at least 70% of rated pressure.
9. Blow down and try gauge cocks to confirm glass water level.
10. Check and test boiler blow down valve.
11. Log operating conditions after the system has stabilized.
12. Review operating procedures
13. Provide a written report of completed work, operating log, and indicate uncorrected deficiencies detected.

Seasonal Shut-down Procedure

1. Shut down boiler at boiler controls.
2. Shut off fuel lines at main valves.
3. Review operating procedures
4. Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

Burners

Gas Train

1. Check the gas train isolation valves for leaks.
2. Check the gas supply piping for leaks.
3. Check the gas pilot solenoid valve for wear and leaks.
4. Check the main gas and the pilot gas regulators for wear and leaks.
5. Test the low gas pressure switch. Calibrate and record setting.
6. Test the high gas pressure switch. Calibrate and record setting.
7. Verify the operation of the burner fan air flow switch.
8. Inspect and clean the burner assembly.
9. Inspect and clean the pilot ignitor assembly.
10. Inspect and clean the burner fan.
11. Run the fan and check for vibration.
12. Inspect the flue and flue damper.
13. Burner Control Panel:
    a) Inspect the panel for cleanliness.
    b) Inspect wiring and connections for tightness and signs of overheating.
14. Clean burner fan wheel and air dampers. Check the fan for vibration.
15. Verify tightness of the linkage set screws.
16. Check the gas valves against leakage (where test cocks are provided

Oil Train

1. Check the gas train isolation valves for leaks.
2. Check the gas supply piping for leaks.

3. Check the gas pilot solenoid valve for wear and leaks.
4. Check the main gas and the pilot gas regulators for wear and leaks.
5. Test the low gas pressure switch. Calibrate and record setting.
6. Test the high gas pressure switch. Calibrate and record setting.
7. Verify the operation of the burner fan air flow switch.
8. Inspect and clean the burner assembly.
9. Inspect and clean the pilot ignitor assembly.
10. Inspect and clean the burner fan.
11. Run the fan and check for vibration.
12. Inspect the flue and flue damper.
13. Burner Control Panel:
    a) Inspect the panel for cleanliness.
    b) Inspect wiring and connections for tightness and signs of overheating.
14. Clean burner fan wheel and air dampers. Check the fan for vibration.
15. Verify tightness of the linkage set screws.
16. Check the gas valves against leakage (where test cocks are provided).

Dual Fuel Train

1. Check the gas train isolation valves for leaks.
2. Check the gas supply piping for leaks.
3. Check the gas pilot solenoid valve for wear and leaks.
4. Check the main gas and the pilot gas regulators for wear and leaks.
5. Test the low gas pressure switch. Calibrate and record setting.
6. Test the high gas pressure switch. Calibrate and record setting.
7. Verify the operation of the burner fan air flow switch.
8. Inspect and clean the burner assembly.
9. Inspect and clean the pilot ignitor assembly.
10. Inspect and clean the burner fan.
11. Run the fan and check for vibration.
12. Inspect the flue and flue damper.
13. Burner Control Panel:
    a) Inspect the panel for cleanliness.
    b) Inspect wiring and connections for tightness and signs of overheating.
14. Clean burner fan wheel and air dampers. Check the fan for vibration.
15. Verify tightness of the linkage set screws.
16. Check the gas valves against leakage (where test cocks are provided)

Cooling Towers

Startup/Checkout Procedure

1. Fill the basin and verify the float level.
2. Verify the operation of the basin heaters
3. Verify the operation, setpoint, and sensitivity of the basin heater temperature control device.
4. Start the condenser water pumps.
5. Verify the balance of the return water through the distribution boxes.
6. Verify proper operation of the bypass valve(s), if applicable.
7. Operate fan and verify smooth operation.
8. Log operation after system has stabilized.
9. Review operating procedures
10. Provide a written report of completed work, operating log, and indicate uncorrected deficiencies detected.

Comprehensive Bi-Annual Inspection

1. Perform following inspection and cleaning before starting the tower for the cooling season and during shutdown at end of season.
2. Record and report abnormal conditions, measurements taken, etc.
3. Review logs for operational problems and trends.
4. General Assembly
   a) Structure
      1. Disassemble all screens and access panels for inspection.
      2. Inspect the conditions of the slats, if applicable.
      3. Inspect the condition of the tower fill.
      4. Inspect the condition of the support structure.
      5. Inspect the condition of the basins (upper and lower) and/or spray nozzles.
      6. Verify clean basins and strainer(s).
      7. Verify the condition and operation of the basin fill valve system.
   b) Mechanical
      1. Inspect belts for wear, cracks, and glazing.
      2. Verify correct belt tension. Adjust the tension as necessary.
      3. Inspect sheaves and pulleys for wear, condition, and alignment.

    4. Inspect fan shaft and bearings for condition.
    5. Inspect fan assembly for condition, security, and clearances. (e.g. blade tip clearance).
4. Lubrication System
    a) Lubricate motor bearings.
    b) Lubricate fan shaft bearings.
5. Motor And Starter
    a) Clean the starter and cabinet.
    b) Inspect wiring and connections for tightness and signs of overheating and discoloration.
    c) Check the condition of the contacts for wear and pitting.
    d) Check the contactor(s) for free and smooth operation.
    e) Meg the motor(s) and record readings.
    f) Check disconnect terminal block for wear, tightness and signs of overheating and discoloration.
    g) Check the condition and operation of the basin heater contactor(s).

Shut-Down Procedure

1. Check the general condition of the tower.
2. Turn off electrical power to basin heaters, tower fans, and pipe heaters as necessary.
3. Drain tower and condenser water piping.
4. Review operating procedures
5. Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

Energy Management System

Maintenance Inspection

1. Review reports for operational problems and trends.
2. Make a back-up copy of the BAS program.
3. Check for loose or damaged parts or wiring.
4. Check for any accumulation of dirt or moisture. Clean if required.
5. Verify proper electrical grounding.

6. Verify control panel power supplies for proper output voltages.
7. Inspect interconnecting cables and electrical connections.
8. Verify that manual override switches are in the desired positions.
9. Check the operation of all binary and analog outputs, if applicable.
10. Calibrate control devices, if applicable.
11. Verify the correct time and date.
12. Check and update the holiday schedules and daylight savings time.
13. Via terminal mode, view the event log and input/output points for any unusual status or override conditions.
14. Clean the external surfaces of the panel enclosure.
15. Review operating program and parameters.
16. Check cable connections for security.
17. Review operating procedures
18. Provide a written report of completed work, and indicate any uncorrected deficiencies detected.

Maintenance Inspection (Control Panels)

1. Control Panel
   a) Verify secure connections on all internal wiring, LAN, and communication links.
   b) Check for loose or damaged parts or wiring.
   c) Check for any accumulation of dirt or moisture. Clean if required.
   d) Remove excessive dust from heat sink surfaces
   e) Verify proper system electrical grounding.
   f) Verify proper output voltages on control panel power supplies.
   g) Check LED Indications to verify proper operation
   h) Verify LAN communications
   i) Verify that cards are seated and secured.
   j) Check wiring trunks and check for possible Error Code Indications
   k) Check voltage level of
   l) Verify the proper operation of critical control processes and points associated with this unit an make adjustments if necessary.
   m) Check Volatile memory available
   n) Cheek Non volatile memory available
   o) Check Processor idle time
   p) Clean external surfaces of the panel enclosure.
   q) Check modem operation, if applicable.

r) View the event log and input/output points for any unusual status or override conditions.
s) Verify correct time and date.
t) Check and update holiday schedules, if applicable, and daylight savings time.
u) Review operating procedures with operating personnel.
v) Provide a written report of completed work, and indicate any uncorrected deficiencies detected.

Maintenance Inspection (EMS - Sequence of Operations)

Central Plant

In order to assure effective environmental conditioning while minimizing the cost to operate the equipment, technicians will review operating sequences and practices for the chiller plant. An initial survey of current equipment operating parameters will be conducted within the first 60 days of the contract term during cooling season. This survey will include:

1. Chiller(s) operation
2. Cooling tower(s) operation
3. Pump(s) operation
4. Economizer operation (where applicable)
5. Environmental safety

A detailed report of findings and recommendations for changes, if any, will be made. Agreed upon operational changes which require only adjustment of controls or programming will be made during regularly scheduled maintenance visits as part of this agreement at no additional cost. Any recommended alterations that require addition of devices or equipment will be accompanied by a guaranteed cost proposal reflecting the applicable discounts determined by this agreement.

Building Systems

In order to assure effective environmental conditioning while minimizing the cost to operate the equipment, technicians will review operating sequences and practices for covered airside systems. An initial survey of current systems operating parameters will be conducted within the first 60 days of the contract term, except seasonally operated systems, which will be surveyed during the appropriate operating season. This survey will include:

1. Time schedule(s)
2. Reset schedule(s)
3. Economizer changeover (where applicable)
4. Setpoints
5. Energy Management routines

A detailed report of findings and recommendations for changes, if any, will be made. Agreed upon operational changes which require only adjustment of controls or programming will be made during regularly scheduled maintenance visits as part of this agreement at no additional cost. Any recommended alterations that require addition of devices or equipment will be accompanied by a guaranteed cost proposal reflecting the applicable discounts determined by this agreement.

Fans

Maintenance Procedure

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.
3. General Assembly
   a) Check the general condition of the unit.
   b) Verify tightness of the fan, fan guards, louvers, etc.
   c) Verify clean burner assembly.
   d) Check sheaves and pulleys for wear and alignment, if applicable.
   e) Check belts for tension, wear, cracks, and/or glazing.
4. Lubrication
   a) Lubricate the fan motor, if applicable.
   b) Lubricate the fan bearings as necessary.
5. Controls and Safeties
   a) Verify proper operation of the temperature control device.
   b) Verify proper operation of the high temperature control device.
   c) Verify proper operation of the fan switch.
   d) Verify proper operation of the pilot safety device, if applicable.
6. Electrical
   a) Inspect wiring and connections for tightness and signs of overheating and discoloration.

7. Startup and Checkout
   a) Start the unit.
   b) Verify proper combustion air to the burner.
   c) Verify proper gas pressure to the burner.
   d) Check the flame for proper combustion.

Comprehensive Annual Inspection

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.
3. General Assembly
   a) Disassemble all screens and panels necessary to gain access to the fan mechanism.
   b) Disassemble the control mechanism (AVPB only).
   c) Clean all accessible rotor components to include control pitch mechanism (AVPB only).
   d) Inspect blades for wear.
   e) Inspect blade arms for wear (AVPB only).
   f) Check blade tip clearance.
   g) Check for oil leak on the blade bearing housing (AVPB only).
   h) Clean motor and fan housing.
   i) Reassemble all removed screens and plates.
4. Lubrication
   a) Lubricate the motor bearings.
   b) Lubricate the shaft bearings (AVPA only).
5. Controls and Safeties
   a) Test the operation of the high static safety device. Calibrate and record setting.
   b) Test the operation of the low static safety device. Calibrate and record setting.
   c) Test the operation of the vibration safety device. Calibrate and record setting.
   d) Verify the operation of the phase monitor, if applicable.
   e) Inspect pneumatic and electrical controls for condition and calibration.
   f) Verify proper operation.
6. Motor and Starter
   a) Clean the starter and cabinet.
   b) Clean the disconnect switch and cabinet at the fan, if applicable.
   c) Inspect the wiring and connections for tightness and signs of overheating and discoloration.
   d) Check the condition of the contacts for wear and pitting.
   e) Check the contactors for free and smooth operation.

   f) Meg the motor and record readings.
7. Startup / Checkout Procedure
   a) Start the fan.
   b) Verify the operation of the starter.
   c) Check and record supply and control air pressure.
   d) Verify the operation of the control system while the fan is operating.
   e) Log the operating conditions after the system has stabilized.
   f) Review operating procedures with operating personnel.
   g) Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

Scheduled Running Inspection (fans)

1. Check the general operation of the fan.
2. Check and record supply and control air pressure.
3. Verify the operation of the control system.
4. Log the operating conditions after the system has stabilized.
5. Review operating procedures with operating personnel.
6. Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

Comprehensive Annual Inspection (fans)

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.
3. General Assembly
   a) Verify tight bolts, set screws, and locking collars.
   b) Inspect sheaves and pulleys for wear and alignment.
   c) Inspect belts for tension, wear, cracks, and glazing.
   d) Inspect dampers for wear, security, and clearances, if applicable.
   e) Verify clean air filters.
   f) Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.
4. Lubrication
   a) Lubricate fan bearings.
   b) Lubricate motor bearings, if applicable.
5. Controls and Safeties

   a) Verify the operation of the control system while the fan is operating.
   b) Verify the setting of the low temperature safety device, if applicable.
   c) Verify the operation of the pre-heat control device, if applicable.
   d) Verify the operation of the cooling control device, if applicable.
   e) Verify the operation of the re-heat control device, if applicable.
   f) Verify the operation of the humidity control device, if applicable.
6. Motor and Starter
   a) Clean the starter and cabinet.
   b) Inspect the wiring and connections for tightness and signs of overheating and discoloration.
   c) Check the condition of the contacts for wear and pitting.
   d) Check the contactors for free and smooth operation.
   e) Meg the motor and record readings.
   f) Check volts and amps of the motor.

Lubricate/Grease Bearings

1. Lubricate and/or grease bearings according to manufacturer's specifications

MEG Motor

1. Check the integrity of the insulation on the motor windings and the motor leads, using a megohm meter.

Coils

Maintenance Procedure

1. Record and report abnormal conditions.
2. Visually inspect the coil for leaks.
3. Inspect the coil for cleanliness.

Pumps

Annual Inspection

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.
3. General Assembly
   a) Check motor shaft and pump shaft for alignment, if applicable.
   b) Inspect the coupling for wear.
   c) Verify that the shaft guard is in place and tight, if applicable.
   d) Verify water flow through the pump.

   e) Check for leaks on the mechanical pump seals, if applicable.
   f) Verify proper drip rate on the pump seal packing, if applicable.
   g) Verify smooth operation of the pump.
   h) Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.
4. Lubrication
   a) Lubricate the motor bearings as necessary.
   b) Lubricate the pump bearings as necessary.
5. Motor and Starter
   a) Clean the starter and cabinet.
   b) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   c) Meg the motor.
   d) Verify tight connections on the motor terminals.
   e) Check the condition of the contacts for wear and pitting, if applicable.
   f) Check the contactors for free and smooth operation.
   g) Verify proper volts and amps.

Pump Run Inspection

1. Verify smooth operation of the pump.
2. Check for leaks on the mechanical pump seals, if applicable.
3. Verify proper drip rate on the pump seal packing, if applicable.
4. Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

Mechanical Starters with Electronic Controls

Comprehensive Annual Maintenance

1. Clean the starter and cabinet.
2. Inspect wiring and connections for tightness and signs of overheating and discoloration.
3. Check condition of the contacts for wear and pitting.
4. Check contactors for free and smooth operation.
5. Check the mechanical linkages for wear, security, and clearances.
6. Verify the overload settings.

VFD Starters

Comprehensive Annual Maintenance

1. Clean the starter and cabinet.
2. Inspect wiring and connections for tightness and signs of overheating and discoloration.
3. Check the tightness of the motor terminal connections.
4. Verify the operation of the cooling loop.
5. Verify proper operation of the frequency drive.

Rooftop Units

Comprehensive Annual Maintenance

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.
3. General Assembly
   a) Inspect for leaks and report results.
   b) Calculate refrigerant loss rate and report to the customer.
   c) Repair minor leaks as required (e.g. valve packing, flare nuts).
   d) Visually inspect condenser tubes for cleanliness.

4. Controls and Safeties
   a) Inspect the control panel for cleanliness.
   b) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   c) Verify the working condition of all indicator/alarm lights, if applicable.
   d) Test the low water temperature control device. Calibrate and record setting.
   e) Test the low evaporator pressure safety device. Calibrate and record setting.
   f) Test the oil pressure safety device. Calibrate and record setting, if applicable.
   g) Check programmed parameters of RCM control, if applicable.
5. Lubrication System
   a) Check oil level in the compressor.
   b) Test oil for acid content and discoloration. Make recommendations to the customer based on the results of the test.
   c) Verify the operation of the oil heater. Measure amps and compare reading with the watt rating of the heater.

6. Motor and Starter
   a) Clean the starter and cabinet.
   b) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   c) Check condition of the contacts for wear and pitting.
   d) Check the contactors for free and smooth operation.
   e) Check the tightness of the motor terminal connections.
   f) Meg the motor and record readings.
   g) Verify the operation of the electrical interlocks.
   h) Measure voltage and record. Voltage should be nominal voltage ± 10%.

Comprehensive Maintenance Inspection (RTU Heating Cycle)

1. Perform heating inspection/maintenance applicable to the unit (steam/hot water, gas, electric).
2. Verify smooth operation of the fans.
3. Check the belts for tension, wear, cracks, and glazing.
4. Verify clean air filters.
5. Gas Heat Option
   a) Visually inspect the heat exchanger.
   b) Inspect the combustion air blower fan, and clean, if required.
   c) Lubricate the combustion air blower fan motor, if applicable.
   d) Verify the operation of the combustion air flow-proving device.

e) Test the operation of the high gas pressure safety device, if applicable. Calibrate, if necessary.
f) Test the operation of the low gas pressure safety device, if applicable. Calibrate, if necessary.
g) Verify the operation of the flame detection device.
h) Test the operation of the high temperature limit switch. i.. Verify the integrity of the flue system.
i) Verify the operation of the operating controls.
j) Verify the burner sequence of operation.
k) Verify proper gas pressure to the unit and/or at the manifold, if applicable.
l) Perform combustion test. Make adjustments as necessary.

6. Electric Heat Option
   a) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   b) Check and calibrate operating and safety controls, if applicable.
   c) Verify the operation of the heating elements.
   d) Check voltage and amperage and compare readings with the watt rating on the heater.

7. Hot Water / Steam Heat Option
   a) Inspect control valves and traps.
   b) Check and calibrate all operating and safety controls.
   c) Verify the operation of the heating coils.
   d) Verify the operation of the unit low temperature safety device.

Mid-Season Cooling Inspection (RTU)

1. Check the general condition of the unit.
2. Log the operating condition after system has stabilized.
3. Verify the operation of the control circuits.
4. Analyze the recorded data. Compare the data to the original design conditions.
5. Review operating procedures with operating personnel.
6. Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

Comprehensive Maintenance Inspection (RTU - Cooling Cycle)

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.

3. General Assembly
   a) Inspect for leaks and report results.
   b) Calculate refrigerant loss rate and report to the customer.
   c) Repair minor leaks as required (e.g. valve packing, flare nuts).
   d) Check pulleys and sheaves for wear and alignment.
   e) Check belts for tension, wear, cracks, and glazing.
   f) Verify clean evaporator coil, blower wheel, and condensate pan.
   g) Verify clean air filters.
   h) Verify proper operation of the condensate drain.
   i) Verify proper operation of the dampers and/or inlet guide vanes, if applicable.
4. Controls and Safeties
   a) Inspect the control panel for cleanliness.
   b) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   c) Verify the working condition of all indicator/alarm lights, if applicable.
   d) Test the low evaporator pressure safety device. Calibrate and record setting, if applicable.
   e) Test the high condenser pressure safety device. Calibrate and record setting, applicable.
   f) Test the oil pressure safety device, if applicable. Calibrate and record setting.
   g) Test the high static pressure safety device, if applicable. Calibrate and record setting.
   h) Verify the operation of the static pressure control device, if applicable.
5. Lubrication
   a) Verify the operation of the oil heater, if applicable.
   b) Lubricate the fan bearings as required.
   c) Lubricate the fan motor bearings as required.
   d) Lubricate the damper bearings, if applicable.
6. Motor and Starter
   a) Clean the starter and cabinet.
   b) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   c) Check the condition of the contacts for wear and pitting.
   d) Check the contactors for free and smooth operation.
7. Startup /Checkout Procedure
   a) Verify the operation of the oil heater.
   b) Verify full water system, including the cooling tower and the condenser.
   c) Verify clean cooling tower and strainers.
   d) Test all flow-proving devices on the condenser water circuit.
   e) Start the condenser water pump and the cooling tower fan(s).

f) Verify flow rate through the condenser.
g) Start the unit.
h) Verify smooth operation of the compressor(s) and fan(s).
i) Check the setpoint and sensitivity of the temperature control device.
j) Verify the operation of the condenser water temperature control device.
k) Verify clean condenser using pressure and temperature.
l) Check operation and setup of the Unit Control Module.
m) Check the superheat and subcooling on the refrigeration circuit(s).
n) Log the operating conditions after the system has stabilized.
o) Review operating procedures with operating personnel.
p) Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

ENERGY SAVINGS PLAN

SECTION 7 – OPTIONAL ENERGY GUARANTEE

OPTIONAL ENERGY GUARANTEE OVERVIEW

***NOTE:** The following is meant only to serve as a description of an optional energy guarantee and does not constitute any contractual obligations between the Ramapo Indian Hills Regional High School District and DCO. If Ramapo Indian Hills Regional High School District chooses to implement an energy guarantee contract, a separate document will be used based on mutual agreement and acceptance of all parties of its terms and conditions.*

A successful energy project consists of a partnership between an ESCO and Owner. Both parties have defined roles and accept their individual responsibilities as well as support any joint initiatives of the program as defined in this document. Both DCO and the Ramapo Indian Hills Regional High School District will have a role in ongoing maintenance and operations as defined in the agreed-upon energy guarantee contractual documents. Both parties will be required to meet their obligations for the guaranteed energy unit savings (referred to as “guarantee or savings”) to be achieved and to ensure the guarantee stays intact.

DCO will guarantee Ramapo Indian Hills Regional High School District will achieve 100% of the total energy unit savings per the provisions of the agreed-upon energy guarantee contractual documents based on the final selection of ECMs and their associated energy savings as measured and verified by the Owner’s third-party, independent firm. The energy savings will be in energy units, not dollars as DCO has no control over the costs of utilities. The energy units guarantee contract shall commence thirty (30) days after the start-up and commissioning of the last Energy Conservation Measure (ECM) and be enforced for a period of one (1) year or until terminated by Ramapo Indian Hills Regional High School District.

SAVINGS VERIFICATION

There are events that cause energy savings to change. Ramapo Indian Hills Regional High School District and DCO will agree to baseline energy consumption that represents the facility’s energy use and cost prior to the date of any Agreement (the “Base Year”) and parameters, which affect the energy usage and cost of the facility, including but not limited to, utility rates, local weather profile, facility square footage, environmental conditions, schedules (e.g., lighting, HVAC) and an inventory of equipment in the facility. Energy savings are determined by comparing measured energy use or demand before and after implementation of an energy savings program.

ECM ENERGY SAVINGS = BASELINE ENERGY USE – POST INSTALLATION ENERGY USE +/- ADJUSTMENTS

Changes in estimated energy savings fall into two categories. These categories are Routine Adjustments and Non-Routine Adjustments. Routine Adjustments are expected changes during the savings reporting period to energy governing factors (e.g. weather). DCO uses IPMVP approved mathematical techniques to determine adjustments. Non-Routine Adjustments include energy-governing factors which are not usually expected to change, such as the facility size, the design and operation of installed equipment, occupancy and the type of occupants or any physical changes to the building or equipment that impact the facilities' utility use. These factors will be monitored for change throughout the reporting period.

DCO will perform monthly utility bill analysis and audit reports which compare the current year with base year energy consumption and costs. DCO will perform periodic on-site analysis to determine whether mechanical and electrical systems are operating at optimal efficiency and to assess the occupancy and operational schedules of the buildings.

As part of the optional energy guarantee, DCO uses weather normalization procedures to correct for the effect of weather variance on energy savings in subsequent years. Baseline energy and weather data are used to establish an algorithm to predict how the baseline building uses energy as a function of weather. The algorithm is then applied to subsequent years to correct for the impact weather may have on future building energy use. The weather normalization procedure and algorithms will be covered in detail as part of the optional energy guarantee contract provided to Ramapo Indian Hills Regional High School District.

ENERGY SAVINGS PLAN

APPENDICIES

APPENDIX LIST	
APPENDIX A	Construction Contingency Allowance
APPENDIX B	Design Bid Build Procedures
APPENDIX C	Operations & Maintenance Savings
APPENDIX D	Project Changes in Financing
APPENDIX E	Incentives in Debt Service
APPENDIX F	ECM Breakdown by Building
APPENDIX G	Lighting Line-by-Line
APPENDIX H	Local Government Energy Audits

ENERGY SAVINGS PLAN

APPENDIX A – CONSTRUCTION CONTINGENCY ALLOWANCE

Appendix A – Construction Contingency Allowance

Experience shows that during the construction phase there are four major categories of potential change of scope issues that benefit from having an appropriate Construction Contingency Allowance (CCA).

- Unknown conditions
- Building inspector's modifications
- Project owner requested changes
- Design clarifications or modifications

Unknown Conditions

Renovations to older facilities have greater potential for revealing unknown. Missing or inaccurate Blueprints, deviations from the original blue prints by the original builder and unknown or undocumented modifications during the life of the facility.

Areas such as behind a wall/roof/equipment or under the slab can bring unforeseen conditions which can delay the new construction and change the anticipated scope of the work. Therefore, it is advisable to dedicate a CCA that is higher than that for new construction.

Building Inspection Modifications

A plan review for the local building jurisdiction reviews the construction documents prior to issuing a building permit. However, there remains the likelihood that the building inspector will request modifications to the plans based upon experience and their interpretation of the applicable building code.

While we can ask for code review and documentation, if you hope to get a Certificate of Occupancy under a tight schedule from this same inspector requested modifications will need to be implemented as successfully appeals take time.

Whether it is adding an extra exit sign, smoke detector or fire extinguisher, or whether it is something more significant, it may require more work from the contractor, thus added expense. The CCA is intended to be the source of funds necessary for these requested modifications.

Project Owner Requested Changes

It is nearly impossible to express your every desire during the design phase. You will always see something during construction that you would like to change.

There is nothing necessarily wrong with that.

The CCA is intended to be the source of funds necessary for these requested changes.

Design Clarifications or Modifications

No designer has ever developed the perfect set of construction documents.

There are always items that can be detailed better or more clearly. The design intent should be adequately reflected in the drawings and specifications so that the contractor can bid and build the ECM to meet the design intent.

However, there will be times during construction when the builder will not be readily able to identify the exact intent of particular details or systems. At that time the builder will submit a Request for Information (RFI) to the designer for clarification or more information. The designer will issue clarifications or directives so that the builder can continue to meet the design intent.

On occasion, the RFI will reveal that something more than was shown in the construction documents is necessary to fulfill the design intent. The clarification or modification may impact the scope of the work to a degree that additional construction costs become necessary.

As long as the design omission is not negligent, the CCA is intended to be the source of funds necessary for these design clarifications or modifications.

Allowance Method

Detailed plans, schematics and specifications for Ramapo Indian Hills Regional High School District were not available to deliver a cost estimate for each ECM. The budgetary costs carried in the project are based on good faith estimates, contractor supplied budgets for similar ECMs on other recent projects and a database of actual installed costs for various ECMs.

a. Allowance Amount (5.64% of Hard Costs)

BID PACKAGE ALLOWANCE SCHEDULE	
ECM	**CONTINGENCY AMOUNT**
LED Lighting Retrofit	$70,278
Lighting Controls	$6,691
Energy Management System Integration	$22,093
Boiler Replacement	$0
Premium Efficiency Pump Motors and VFDs	$0
Building Envelope Weatherization	$7,798
Freezer Thermostat Control	$1,080
Water Conservation	$1,761
Plug Load Controls	$1,745
Retro-Commissioning	$12,294
Solar PPA	$0
Roofing Upgrades	$129,144
TOTAL	**$252,884**

ENERGY SAVINGS PLAN

APPENDIX B – DESIGN BID BUILD

Appendix B – Design Bid Build Procedures

Design–bid–build (or **design/bid/build**, and abbreviated **D–B–B** or **D/B/B** accordingly), also known as **Design–tender** (or "design/tender") **traditional method** or **hard bid** is the method of delivery for this project.

Design–bid–build is the traditional method for project delivery and differs in several substantial aspects from design–build.

There are three main sequential phases to the design–bid–build delivery method:

- The design phase
- The bidding (or tender) phase
- The construction phase

Design Phase

In this phase DCO will design and produce bid documents, including construction drawings and technical specifications, on which various contractors will in turn bid to construct the project.

The Energy Savings Plan (ESP) is intended to document owner's project requirements and provide a conceptual and/or schematic design and good faith estimates.

With the ESP DCO will bring in other design professionals including mechanical, electrical, and plumbing engineers (MEP specifications engineers), a fire protection engineer, structural engineer, sometimes a civil engineer and a landscape architect to help complete the construction drawings and technical.

The design document should reflect the intent of the energy savings plan for scope, price, savings, operations & maintenance savings, incentive and schedule.

The finished bid documents are coordinated by the DCO and owner for issuance to contractors during the bid phase.

Bid (or tender) phase

Bidding is according to NJ Public Bid Law and is "open", in which any qualified bidder may participate.

The various contractors bidding obtain bid documents, and then put them out to multiple subcontractors for bids on sub-components of the project.

Questions may arise during the bid period, and DCO will issue clarifications or corrections to the bid documents in the form of addenda.

From these elements, the contractor compiles a complete bid for submission by the established closing date and time bid date.

Bids are to be based on a base bid lump sum plus alternates, bid requirements and alternates are elucidated within the bid documents.

Once bids are received, DCO reviews the bids, seeks any clarifications required of the bidders, investigates contractor qualifications, ensures all documentation is in order (including bonding if required), and advises the owner as to the ranking of the bids.

If the bids fall in a range acceptable to the owner, the project is awarded to the contractor with the lowest reasonable bid.

In the event that all of the bids do not satisfy the needs of the owner the following options become available to DCO:

- Re-bid the construction of the project on a future when monies become available and/or construction costs go down.
- Revise the design of that ECM (at no cost to the client) so as to make the project smaller or reduce features or elements of the project to bring the cost down. The revised bid documents can then be issued again for bid.
    - DCO will provide guidance on energy savings, operation and maintenance savings and incentives to ensure the project is self-funding.
- Revise the design of future ECM(s) (at no cost to the client) so as to make the project smaller or reduce features or elements of the project to bring the cost down. The current bid package can then be contracted
    - DCO will provide guidance on energy savings, operation and maintenance savings and incentives to ensure the project is self-funding.

Construction phase

Once the construction of the project has been awarded to the contractor, the bid documents (e.g., approved construction drawings and technical specifications) may not be altered.

The necessary permits (for example, a building permit) must be achieved from all jurisdictional authorities in order for the construction process to begin.

Should design changes be necessary during construction, whether initiated by the contractor, owner, or as discovered by the architect, DCO will issue sketches or written clarifications and handle the project through allowance (See Appendix A).

The contractor may be required to document "as built" conditions to the owner.

Bidding Method

1. To achieve energy savings and fund debt service payments as rapidly as possible the bid packages will be bid in the following order:

BID METHOD SCHEDULE		
ECM	COST + ALLOWANC	SAVINGS
Solar PPA	$0	$150,710
Boiler Replacement	$0	$5,959
Premium Efficiency Pump Motors and	$0	$3,148
LED Lighting Retrofit	$1,316,453	$124,730
Lighting Controls	$125,339	$8,274
Energy Management System Integratio	$413,840	$34,994
Retro-Commissioning	$230,294	$18,612
Building Envelope Weatherization	$146,071	$11,068
Freezer Thermostat Control	$20,234	$3,099
Roofing Upgrades	$2,419,144	$1,240
Plug Load Controls	$32,685	$2,174
Water Conservation	$32,995	$3,007

2. Bids in group 1 (Green) are within 15% of budget value they will be awarded.
3. Bids in group 2 (Yellow) may be value engineered from the project to meet budget
   a. DCO will provide the impact of ECMs value engineered:
      i. Energy Savings
      ii. Operations and Maintenance Savings
      iii. Incentive
4. Bids in group 3 (Red) may be value engineered **or removed** from the project to meet budget
   a. DCO will provide the impact of ECMs value engineered or removed:
      i. Energy Savings
      ii. Operations and Maintenance Savings
      iii. Incentive
5. As per ESIP law DCO fee will be applied to the ECM hard cost.
   a. DCO will receive no compensation for bids that are under budget
   b. DCO will receive no penalty for bids that are over budget
6. If the budget overruns make savings unachievable at the current budget, DCO will provide additional ECMs above the budget to meet the required energy savings

ENERGY SAVINGS PLAN

APPENDIX C – OPERATIONS AND MAINTENANCE SAVINGS

Appendix C – Operation & Maintenance Savings

Operations and Maintenance and other non-energy-related cost savings are allowable in NJ ESIPs, and are defined as reduction in expenses (other than energy cost savings) related to energy and water consuming equipment:

Energy-related cost savings can result from avoided expenditures for operations, maintenance, equipment repair, or equipment replacement due to the ESIP project.

Sources of O&M savings include:

- Termination of service personnel
- Lower maintenance service contract costs
- Decrease in repair costs
    - Avoided repair and replacement costs as a result of replacing old and unreliable equipment
    - Material savings due to new equipment warranties
    - Material savings due to the longer life items not needing replacement
        - In particular, reduction in florescent bulbs due to LED

Termination of service personnel

As a result of the ESIP, a number of the client's maintenance staff members may no longer be required. If there will be a reduction in the government's maintenance staff, O&M savings can be claimed.

A problem could arise if the maintenance staff is not reduced. Then it would be necessary to determine what new O&M responsibilities the facility has taken on, or savings should not be claimed. For example, it could be that a new building was constructed. During the performance period, it is important to establish that any increased maintenance was not due to the equipment installed under the ESIP

Lower maintenance service contract costs

Prior to the implementation of the ESIP mechanical and electrical equipment was maintained by a third party under a maintenance contract. The ESIP replaces the aging equipment with newer, more efficient equipment, which can reduce the service costs to the client.

Decrease in repair costs

The client is responsible for maintenance both before and after the equipment installation. Although there is no reduction in staff for which to claim labor savings, there will be cost savings on replacement materials.

Material-related savings frequently result from lighting and lighting controls projects.

For this project, lighting maintenance savings will result from the following:

1. Reduced material requirements (e.g., lamps)
2. Reduced operating time — Control measures increase equipment life by reducing the burn time of lamps and ballasts
3. Warranty-related savings — newly installed lamps, and fixtures come with a manufacturer warranty of 10 years.

Year 1 O&M Savings

RAMAPO INDIAN HILLS RHSD		ANNUAL O&M COST SAVINGS
ECM #	ENERGY CONSERVATION MEASURE	$
1	LED Lighting Retrofit	$18,285
3	Energy Management System Integration	$10,754
4	Boiler Replacement	$4,169
	TOTALS	$33,208

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ENERGY SAVINGS PLAN

APPENDIX D – PROJECT CHANGES IN FINANCING

Appendix D – Project Changes in Financing

The Energy savings plan has been approved using:

Interest rate of: 3.5%
Term: .... 15 Years
Construction Term .... 12 Months
Construction Interest Only Payment of .... TBD by RIHRHSD financial advisor
Annual Surplus of no less than $2,400

During financing DCO will provide assistance but does not guarantee the timing of savings or incentives.

While beneficial to the client financing changes are the responsibility of the client, bond counsel and/or financial advisor. DCO represents in no way advice on these financial items

Financial items may include but are not limited to:

- Timing of payments
- Splitting payments into bi-annual, tri-annual, etc.
- Coordination with the client’s fiscal year
- Local finance board material, forms and presentations
- Multiple tiered interest rates

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ENERGY SAVINGS PLAN

APPENDIX E – INCENTIVES IN DEBT SERVICE

Appendix E – Incentives in Debt Service

All estimated incentive values for RIHRHSD ESIP project were provided by PSE&G through the Engineered Solutions Program. The total incentive amount was calculated to be $931,358.52. The Engineered Solutions program is estimated to cover 57% of the installed cost of the improvements with the remainder financed within the ESIP.

PSEG

Engineered Solutions
Energy Efficiency Program

Date: 11/1/2022

Ramapo Indian Hills BOE ESIP

Item	Measure Description	Measure Cost ($)	1st Year Measure Savings ($)
1	Interior & Exterior Lighting	$1,217,443.66	$128,003
2	Lighting Controls	$118,648.13	$8,533
3			
4			
5	Building Envelope Weatherization	$138,273.00	$10,539
6			
7	Freezer Thermostat Control	$19,154.22	$4,094.06
8	Low Flow Fixtures	$31,234.11	$1,183.47
9	Plug Load Controls	$30,939.98	$2,872.61
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
	Total ECM Cost	$1,555,693.10	
	Construction Management		
	Total Advanced Project Cost	$1,555,693.10	
	Engineering Costs	$77,784.66	
	Total Project Cost	$1,633,477.76	$155,226

Summary Table		
Customer Payback from Savings (Yrs.)		4.5
Customer Share of the Project Cost	$	702,119.24
PSE&G Share of the Project Cost	$	931,358.52
Customer % Share of the Project Cost		43%
PSE&G % Share of the Project Cost		57%
Stage 1 - Initial Payment	$	466,707.93
1st Year Measure Savings	$	155,226.42
Annual Loan Repayment	$	(140,423.85)
1st Year Net Cash Flow	$	14,802.57
Monthly Payment	$	11,701.99

No implied and/or written guarantee is made with respect to the receipt of incentives. All incentives estimates carry inherent risks that may jeopardize the receipt of them. Therefore, Ramapo Indian Hills Regional High School District acknowledges and accepts that any project proposed should not rely on the receipt of incentives as a reason to implement it.

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ENERGY SAVINGS PLAN

APPENDIX F – ECM BREAKDOWN BY BUILDING

RAMAPO INDIAN HILLS RHSD % SAVINGS BY BUILDING (T.O.R.)								
RAMAPO INDIAN HILLS RHSD BUILDINGS/FACILITIES		UTILITY ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	ONSITE ELECTRIC SAVINGS	NATURAL GAS SAVINGS	ONSITE NATURAL GAS SAVINGS	Water & Sewer (Gal) SAVINGS
BUILDING/FACILITY NAME	SQFT	kWh	kW	kWh	THERMS	THERMS	Water & Sewer (Gal)
Ramapo High School	241,600	30.9%	30.0%	30.9%	30.5%	30.5%	8.1%
Indian Hills High School	240,320	31.3%	28.7%	31.3%	22.8%	22.8%	7.4%
TOTALS	**481,920**	**31.1%**	**29.4%**	**31.1%**	**26.7%**	**26.7%**	**7.8%**

RAMAPO INDIAN HILLS RHSD SAVINGS BY BUILDING BY UTILITY FROM SMART SELECT							
RAMAPO INDIAN HILLS RHSD BUILDINGS/FACILITIES		ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	ONSITE ELECTRIC SAVINGS	NATURAL GAS SAVINGS	ONSITE NATURAL GAS SAVINGS	Water & Sewer (Gal) SAVINGS
BUILDING/FACILITY NAME	SQFT	kWh	kW	kWh	THERMS	THERMS	Water & Sewer (Gal)
Ramapo High School	241,600	689,597	210	689,597	36,779	36,779	124,292
Indian Hills High School	240,320	657,704	210	657,704	27,266	27,266	88,062
TOTALS	**481,920**	**1,347,301**	**421**	**1,347,301**	**64,045**	**64,045**	**212,355**

RAMAPO INDIAN HILLS RHSD			INCLUDED IN PROJECT	INSTALLED COST	ANNUAL ELECTRIC COST SAVINGS	ANNUAL NATURAL GAS COST SAVINGS	ANNUAL Water & Sewer (Gal) COST SAVINGS	ANNUAL ENERGY COST SAVINGS
ECM #	BUILDING/FACILITY	ENERGY CONSERVATION MEASURE	"Y" OR "N"	$	$	$	$	$
1	Ramapo High School	LED Lighting Retrofit	Y	$596,444	$62,119	($799)	$0	$61,320
2	Ramapo High School	Lighting Controls	Y	$74,255	$5,486	($71)	$0	$5,415
3	Ramapo High School	Energy Management System Integration	Y	$189,582	$3,807	$14,783	$0	$18,590
4	Ramapo High School	Boiler Replacement	Y	$0	$0	$5,959	$0	$5,959
5	Ramapo High School	Premium Efficiency Pump Motors and VFDs	Y	$0	$3,148	$0	$0	$3,148
8	Ramapo High School	Building Envelope Weatherization	Y	$61,751	$1,724	$4,138	$0	$5,862
10	Ramapo High School	Freezer Thermostat Control	Y	$12,097	$1,851	$0	$0	$1,851
11	Ramapo High School	Water Conservation	Y	$21,269	$0	$665	$1,268	$1,932
12	Ramapo High School	Plug Load Controls	Y	$6,410	$586	$0	$0	$586
13	Ramapo High School	Retro-Commissioning	Y	$109,000	$5,921	$3,510	$0	$9,431
14	Ramapo High School	Solar PPA	Y	$0	$87,543	$0	$0	$87,543
16	Ramapo High School	Roofing Upgrades	Y	$1,310,000	$151	$577	$0	$728
	Ramapo High School	TOTALS		$2,380,808	$172,337	$28,761	$1,268	$202,366

RAMAPO INDIAN HILLS RHSD			INCLUDED IN PROJECT	ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	NATURAL GAS SAVINGS	Water & Sewer (Gal) SAVINGS	INCENTIVES CLAIMED
ECM #	BUILDING/FACILITY	ENERGY CONSERVATION MEASURE	"Y" OR "N"	kWh	kW	THERMS	Water & Sewer (Gal)	TYPE
1	Ramapo High School	LED Lighting Retrofit	Y	490,523	173.5	-1,022	0	ENGINEERED SOLUTIONS
2	Ramapo High School	Lighting Controls	Y	43,339	15.3	-91	0	ENGINEERED SOLUTIONS
3	Ramapo High School	Energy Management System Integration	Y	31,793	7.7	18,904	0	
4	Ramapo High School	Boiler Replacement	Y	0	0.0	7,620	0	
5	Ramapo High School	Premium Efficiency Pump Motors and VFDs	Y	29,670	2.7	0	0	
8	Ramapo High School	Building Envelope Weatherization	Y	7,439	11.1	5,292	0	ENGINEERED SOLUTIONS
10	Ramapo High School	Freezer Thermostat Control	Y	18,891	0.0	0	0	ENGINEERED SOLUTIONS
11	Ramapo High School	Water Conservation	Y	0	0.0	850	124,292	ENGINEERED SOLUTIONS
12	Ramapo High School	Plug Load Controls	Y	5,975	0.0	0	0	ENGINEERED SOLUTIONS
13	Ramapo High School	Retro-Commissioning	Y	60,420	0.0	4,488	0	
14	Ramapo High School	Solar PPA	Y	0	0.0	0	0	
16	Ramapo High School	Roofing Upgrades	Y	1,546	0.0	738	0	
	Ramapo High School	TOTALS		689,597	210.4	36,779	124,292	

RAMAPO INDIAN HILLS RHSD			INCLUDED IN PROJECT	INSTALLED COST	ANNUAL ELECTRIC COST SAVINGS	ANNUAL NATURAL GAS COST SAVINGS	ANNUAL Water & Sewer (Gal) COST SAVINGS	ANNUAL ENERGY COST SAVINGS
ECM #	BUILDING/FACILITY	ENERGY CONSERVATION MEASURE	"Y" OR "N"	$	$	$	$	$
1	Indian Hills High School	LED Lighting Retrofit	Y	$649,732	$64,191	($781)	$0	$63,410
2	Indian Hills High School	Lighting Controls	Y	$44,393	$2,894	($35)	$0	$2,859
3	Indian Hills High School	Energy Management System Integration	Y	$202,166	$4,211	$12,193	$0	$16,404
8	Indian Hills High School	Building Envelope Weatherization	Y	$76,522	$1,067	$4,140	$0	$5,207
10	Indian Hills High School	Freezer Thermostat Control	Y	$7,057	$1,248	$0	$0	$1,248
11	Indian Hills High School	Water Conservation	Y	$9,965	$0	$439	$636	$1,075
12	Indian Hills High School	Plug Load Controls	Y	$24,530	$1,589	$0	$0	$1,589
13	Indian Hills High School	Retro-Commissioning	Y	$109,000	$5,581	$3,600	$0	$9,181
14	Indian Hills High School	Solar PPA	Y	$0	$81,932	$0	$0	$81,932
16	Indian Hills High School	Roofing Upgrades	Y	$980,000	$109	$403	$0	$512
	Indian Hills High School	TOTALS		$2,103,364	$162,821	$19,959	$636	$183,416

RAMAPO INDIAN HILLS RHSD			INCLUDED IN PROJECT	ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	NATURAL GAS SAVINGS	Water & Sewer (Gal) SAVINGS	INCENTIVES CLAIMED
ECM #	BUILDING/FACILITY	ENERGY CONSERVATION MEASURE	"Y" OR "N"	kWh	kW	THERMS	Water & Sewer (Gal)	TYPE
1	Indian Hills High School	LED Lighting Retrofit	Y	512,073	181.1	-1,067	0	ENGINEERED SOLUTIONS
2	Indian Hills High School	Lighting Controls	Y	23,096	8.2	-48	0	ENGINEERED SOLUTIONS
3	Indian Hills High School	Energy Management System Integration	Y	30,802	14.0	16,658	0	
8	Indian Hills High School	Building Envelope Weatherization	Y	4,726	7.1	5,656	0	ENGINEERED SOLUTIONS
10	Indian Hills High School	Freezer Thermostat Control	Y	12,731	0.0	0	0	ENGINEERED SOLUTIONS
11	Indian Hills High School	Water Conservation	Y	0	0.0	600	88,062	ENGINEERED SOLUTIONS
12	Indian Hills High School	Plug Load Controls	Y	16,213	0.0	0	0	ENGINEERED SOLUTIONS
13	Indian Hills High School	Retro-Commissioning	Y	56,948	0.0	4,919	0	
14	Indian Hills High School	Solar PPA	Y	0	0.0	0	0	
16	Indian Hills High School	Roofing Upgrades	Y	1,114	0.0	550	0	
	Indian Hills High School	TOTALS		657,704	210.3	27,266	88,062	

ECM Breakdown by Building by Greenhouse Gas Reductions

RAMAPO INDIAN HILLS RHSD			INCLUDED IN PROJECT	Reduction of CO_2	Reduction of NO_x	Reduction of SO_2	Reduction of Hg
ECM #	BUILDING/FACILITY	ENERGY CONSERVATION MEASURE	"Y" OR "N"	LBS	LBS	LBS	LBS
1	Ramapo High School	LED Lighting Retrofit	Y	527,616	457	1,084	2,281
2	Ramapo High School	Lighting Controls	Y	46,613	40	96	202
3	Ramapo High School	Energy Management System Integration	Y	256,150	204	70	148
4	Ramapo High School	Boiler Replacement	Y	89,157	70	0	0
5	Ramapo High School	Premium Efficiency Pump Motors and VFDs	Y	32,637	28	66	138
8	Ramapo High School	Building Envelope Weatherization	Y	70,094	56	16	35
10	Ramapo High School	Freezer Thermostat Control	Y	20,781	18	42	88
11	Ramapo High School	Water Conservation	Y	9,945	8	0	0
12	Ramapo High School	Plug Load Controls	Y	6,573	6	13	28
13	Ramapo High School	Retro-Commissioning	Y	118,972	99	134	281
14	Ramapo High School	Solar PPA	Y	1,612,717	1,393	3,240	6,817
16	Ramapo High School	Roofing Upgrades	Y	10,330	8	3	7
	Ramapo High School	TOTALS		2,801,584	2,386	4,764	10,024

RAMAPO INDIAN HILLS RHSD			INCLUDED IN PROJECT	Reduction of CO_2	Reduction of NO_x	Reduction of SO_2	Reduction of Hg
ECM #	BUILDING/FACILITY	ENERGY CONSERVATION MEASURE	"Y" OR "N"	LBS	LBS	LBS	LBS
1	Indian Hills High School	LED Lighting Retrofit	Y	550,791	477	1,132	2,381
2	Indian Hills High School	Lighting Controls	Y	24,841	21	51	107
3	Indian Hills High School	Energy Management System Integration	Y	228,775	183	68	143
8	Indian Hills High School	Building Envelope Weatherization	Y	71,371	57	10	22
10	Indian Hills High School	Freezer Thermostat Control	Y	14,005	12	28	59
11	Indian Hills High School	Water Conservation	Y	7,015	6	0	0
12	Indian Hills High School	Plug Load Controls	Y	17,834	15	36	75
13	Indian Hills High School	Retro-Commissioning	Y	120,192	99	126	265
14	Indian Hills High School	Solar PPA	Y	1,509,343	1,304	3,032	6,380
16	Indian Hills High School	Roofing Upgrades	Y	7,663	6	2	5
	Indian Hills High School	TOTALS		2,551,828	2,179	4,486	9,439

Note:

- **Factors used to calculate Greenhouse Gas Reductions are as follows:**
  - ***CO2 = (1.292*kWh Savings) + (11.7*Therm Savings)***
  - ***NOx = (0.0083*kWh Savings) + (0.0092*Therm Savings)***
  - ***SO2 = (0.0067*kWh Savings)***
  - ***Hg = (0.0000000243* kWh Savings)***

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ENERGY SAVINGS PLAN

APPENDIX G – LIGHTING LINE BY LINE

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ENERGY SAVINGS PLAN

APPENDIX H – LOCAL GOVERNMENT ENERGY AUDITS