Passaic County Community College

Energy Savings Plan

Rev2.3

December 29, 2023

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1.0 Executive Summary

1.1 Overview of the Energy Savings Improvement Program

The Energy Savings Improvement Program (ESIP) was created in 2009 by the NJ legislature to reduce energy & operational costs, reinvest in infrastructure, and support the individual goals of public entities across the state. ESIP is a design-build financing mechanism that is regulated by the NJ Board of Public Utilities (BPU). Passaic County Community College (PCCC) will implement an ESIP that addresses building energy and infrastructure needs.

Schneider Electric was hired by PCCC via a national cooperative contract under 1GPA. This project is done under the ESCO model with no architect/engineer of record. The College hired Concord Energy Services as the 3rd party reviewer. The College's bond counsel is McManimon, Scotland, and Baumann, LLC and financial advisor is NW Financial.

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

1. Reduce energy and operational expenses
2. Improve indoor air quality and comfort inside the facilities
3. Replace building infrastructure that is beyond its useful life
4. Provide an improved learning and teaching environment
5. Become more sustainable & support the College's solar training certification program

The ECMs in the Energy Savings Plan include HVAC upgrades, Building Automation System (BAS) upgrades, building envelope improvements, solar PV, and LED lighting. The following tables provide an overview of the ECMs included at each facility.

2.0 Financial Analysis

2.1 Scope Summary

The intent of this project is to maximize savings for the College, improve indoor air conditions, reduce maintenance costs, and fund critical capital improvements. The below matrix demonstrates where scope is applicable to each building.

	Founders Hall	Academic Hall	Hamilton Hall	Wanaque Academic Center	Hamilton Club	Public Safety Academy	Community Technology Center	Broadway Academic Center	Pruden Building	Passaic Academic Center	Maintenance/ Receiving Warehouse	Memorial Hall	Enrollment and Student Services Center	Institue for America's New and Emerging Workforce	Zendell Hall
Efficiency & Sustainability															
LED Lighting	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		🟩
BAS Schedules & Setpoints	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		🟩
Building Envelope	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		🟩
Solar PV	🟩	🟩	🟩	🟩		🟩				🟩		🟩		🟩	
HVAC															
Boiler Replacement		🟩	🟩												
Chiller Replacement ET/AS (1 Chiller)		🟩													
Gym Rooftop Unit Replacement (add AC)															
Various HVAC	🟩		🟩	🟩	🟩	🟩	🟩	🟩	🟩				🟩		
Combined Heat and Power		🟩													
Other Infrastructure															
Electrical Upgrades			🟩												
Window Replacement		🟩													

#	ECM	Hard Costs	Rebate	ITC Incentive	Annual Savings
	Efficiency				
1	LED Lighting	$ 1,105,326	$73,001		$109,892
2	BAS - Schedules and Setpoints	$ 274,991			$139,355
3	Building Envelope	$ 180,319			$22,387
	Solar PV				
4A	Paterson Campus	$ 3,024,100		$1,542,291	$94,313
4B	Public Safety Academy	$ 837,132		$272,172	$41,266
4C	Wanaque	$ 1,765,136		$573,890	$67,617
4D	Passaic Academic Center	$ 409,110		$208,646	$13,142
4E	PSA Remote Net Metering	$ 1,760,527		$572,391	$54,626
	Mechanical				
5	Boiler Replacement	$ 1,769,652	$38,500		$9,678
6	Chiller Replacement (1)	$ 1,227,357	$29,063		$21,466
7	Gym RTUs (Add AC - Typical Load)	$ 713,031			$7,715
9	Various HVAC, Campus Wide	$ 868,300	$2,750		$14,770
10	Combined Heat and Power (CHP)	$ 235,201			$2,110
	Electrical				
11	Hamilton Hall Electrical Gear	$ 207,422		$105,785	
	Windows				
12	Academic: South and West Façade	$ 1,292,398			$2,405
	Project Summary:	**$ 15,670,003**	**$143,314**	**$3,275,176**	**$600,741**

Many of the above measures include scope that can be considered facility alterations. Some examples include replacement of battery backups for lights, electrical upgrades necessary to facility solar, and access path modifications necessary to install boilers and chillers.

2.2 Financial Summary

The table below represents the total, turn-key cost of the ESIP based on the scope of work listed on the prior page.

Category	Cost	Percentage of Hard Costs
Estimated Value of Hard Costs:	$15,670,003	
Project Service Fees		
Investment Grade Energy Audit	$ 156,700	1.00%
Design Engineering Fees	$ 783,500	5.00%
Construction Management & Project Administration	$ 940,200	6.00%
System Commissioning	$ 470,100	3.00%
Equipment Initial Training Fees	$ 156,700	1.00%
ESCO Overhead	$ 940,200	6.00%
ESCO Profit	$ 861,850	5.50%
Project Service Fees Sub Total	$ 2,507,200	16.00%
TOTAL PROJECT COSTS:	$19,979,253	27.50%

NOTES:

(1) Fees should include all mark-ups, overhead, and profit. Figures stated as a range will NOT be accepted.

(2) The total value of Hard Costs is defined in accordance with standard AIA definitions that include:

Labor Costs, Subcontractor Costs, Cost of Materials and Equipment, Temporary Facilities and Related Items, and Miscellaneous Costs such as Permits, Bonds Taxes, Insurance, Mark-ups, Overhead and Profit, etc.

2.3 Cash Flow Analysis

The table below represents the total, turnkey cost of the ESIP based on the scope of work listed on the prior page.

ESCO Name: Schneider Electric

Note: This energy savings plan is based on the following assumptions in all financial calculations:
(a) The cost of all types of energy should be assumed to inflate at 2.4% for Natural Gas, 2.2% for Electric.
1. Term of Agreement: 20 Years
2. Construction Period (months): 12

ESP Financing

Turn-key ECMs w/ SE:	$	19,979,253
Chapter 12 Funding:	$	5,970,130
Cost of Issuance:	$	160,000
Capital Contribution:	$	4,812,015
Total Financed Cost:	$	9,357,108

Year	Annual Electric (Non Solar) Savings	Annual Electric (Solar Only) Savings	Annual NG Savings	Annual O&M Savings	Rebates	Total Annual Savings	ESIP Financing Costs	Net Cash-Flow to Client	Cumulative Cash Flow
Installation	$128,291		$36,598			**$164,889**		$106,555	$106,555
1	$256,581	$270,964	$73,196	$45,465	$3,377,240	**$4,023,445**	$643,205	$3,380,240	$3,486,794
2	$262,226	$275,540	$74,953	$45,465		**$658,183**	$655,183	$3,000	$3,489,794
3	$267,995	$280,194	$76,752	$4,700		**$629,640**	$626,640	$3,000	$3,492,794
4	$273,891	$284,927	$78,594	$4,700		**$642,111**	$639,111	$3,000	$3,495,794
5	$279,916	$289,739	$80,480	$4,700		**$654,835**	$651,835	$3,000	$3,498,794
6	$286,074	$294,633	$82,411			**$663,118**	$660,118	$3,000	$3,501,794
7	$292,368	$299,609	$84,389			**$676,366**	$673,366	$3,000	$3,504,794
8	$298,800	$304,669	$86,415			**$689,884**	$686,884	$3,000	$3,507,794
9	$305,374	$309,815	$88,489			**$703,678**	$700,678	$3,000	$3,510,794
10	$312,092	$315,048	$90,612			**$717,752**	$714,752	$3,000	$3,513,794
11	$318,958	$320,369	$92,787			**$732,114**	$729,114	$3,000	$3,516,794
12	$325,975	$325,780	$95,014			**$746,769**	$743,769	$3,000	$3,519,794
13	$333,146	$331,283	$97,294			**$761,723**	$758,723	$3,000	$3,522,794
14	$340,476	$336,878	$99,629			**$776,983**	$773,983	$3,000	$3,525,794
15	$347,966	$342,568	$102,020			**$792,554**	$789,554	$3,000	$3,528,794
16	$355,621	$348,354	$104,469			**$808,444**	$805,444	$3,000	$3,531,794
17	$363,445	$354,238	$106,976			**$824,659**	$821,659	$3,000	$3,534,794
18	$371,441	$360,221	$109,543			**$841,205**	$838,205	$3,000	$3,537,794
19	$379,613	$366,305	$112,173			**$858,090**	$855,090	$3,000	$3,540,794
20	$387,964	$372,492	$114,865			**$875,320**	$868,511	$6,809	$3,547,604
Totals	**$6,488,213**	**$6,383,625**	**$1,887,658**	**$105,029**	**$3,377,240**	**$18,241,765**	**$14,635,827**	**$3,605,938**	

The following notes are applicable to the cashflow.

1) No Payments are made during the construction period.

2) As of 7/1/21, Board approved utility EE programs replaced certain NJ CEP offerings. Subsequently, the BPU is requiring that all ESIP projects consult with the DCA and follow all DCA guidance regarding the procurement of all subcontractors. Additionally utility incentives must be detailed on ESIP forms.

2.4 Incentives and Rebates

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

Utility Rebates

ECM	Rebate	Program
LED Lighting	$ 73,001	PSEG -Perscriptive
Boiler Replacement	$ 38,500	PSEG -Perscriptive
Chiller Replacement (1)	$ 29,063	PSEG -Perscriptive
Wanaque RTUs	$ 2,750	PSEG -Perscriptive
Project Summary	**$ 143,314**	

Note: under PSEG's current program, a customer can not apply for both the prescriptive program and PJM's Permanent Demand Reduction program.

Federal Investment Tax Credit – Direct Pay

Campus	Eligible Cost	Tax Exempt Financing	ITC Percentage	ITC Value	Program
Paterson	$ 4,120,159	No	40%	$ 1,648,064	Federal
Passaic	$ 521,612	No	40%	$ 208,645	Federal
Public Safety	$ 3,311,991	Yes	30%	$ 844,558	Federal
Wanaque	$ 2,250,532	Yes	30%	$ 573,886	Federal
Total				$ 3,275,151	

Notes: If tax exempt financing is used, IRA ITC value reduced by 15%,
The Hamilton Hall electrical gear replament is nessesary to replace for the solar PV and thus included in the Paterson Campus eligible cost.

Through the Inflation Reduction Act passed in August of 2022, public governments can capture the investment tax credit (ITC) through the direct pay mechanism. Systems under 1MW qualify for a 30% credit and systems located in low-income areas are eligible for an additional 10% credit value. Paterson and Passaic New Jersey meet the requirements for low income as shown here. The credit is expected to be paid back in the year after the system is operational.

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

Demand Response Program / Curtailable Energy Services

Demand response and curtailable energy services are available to large energy users that can dynamically shift their energy consumption and usage patterns. Passaic County Community college has many small meters and few activities that can be modified quickly or based on weather. Based on the consumption of even the largest meters, PCCC is not a good fit for demand response or curtailable energy services.

3.0 Energy Conservation Measures

3.1 ECM Descriptions

Please see the following descriptions of ECMs currently included in the project.

1) LED Lighting

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

A standardized lighting system will simplify maintenance and provide consistent lighting color and performance throughout PCCC's facilities. The long life of LED tubes and fixtures will result in fewer burnouts, longer intervals between replacements and reduced maintenance costs.

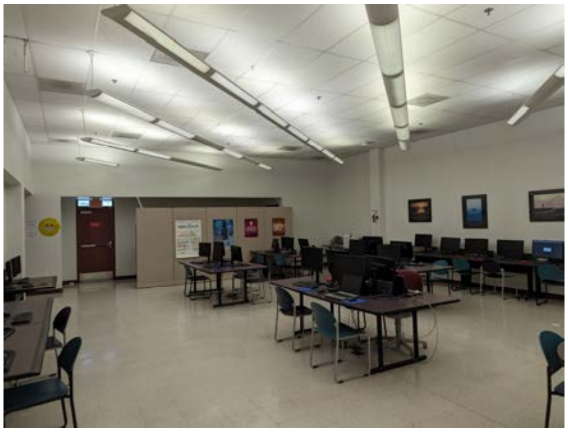


Figure 1. Existing Lighting at Wanaque Campus

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

2) Building Automation Systems – Schedules and Setpoints

Most of the HVAC system controls for schedules and setpoints are not in alignment with College operation. As part of this ECM, Schneider Electric will either modify exiting controls systems, install new enable/disable controls or install new programmable thermostats with correct schedules. The standards of comfort (see appendix) outline what can be reasonably expected for building operation.

New thermostats will be provided and commissioned as part of this scope of work for the following buildings:

- Pruden
- Broadway Academic Center
- CTC
- Hamilton Club
- Founders Hall
- Game Room

The following building automation systems will be modified to meet the standards of comfort document:

- Academic Addition
- Passaic Academic Center
- Memorial Hall (x2 systems)

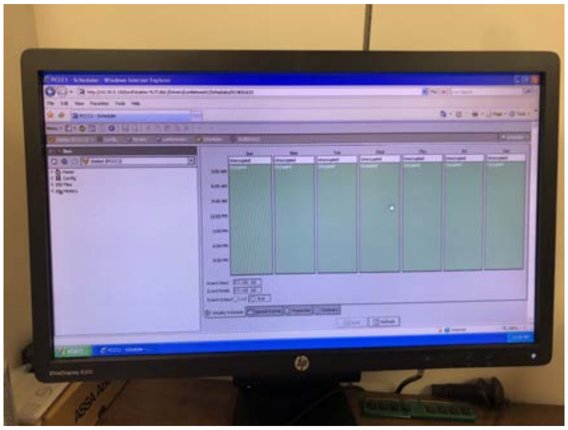


Figure 2. Existing BAS Schedule for Memorial Hall

The green bars show this schedule runs 24/7.

The following sites will have equipment integrated into an existing automation system:

- Hamilton Hall
- Wanaque
- Enrollment and student services center
- Founder’s gym
- Public Safety Academy

Enable and disable control will be provided to the Academic Basement AHUs. Existing pneumatic room thermostats will continue to operate the perimeter hot water baseboard.

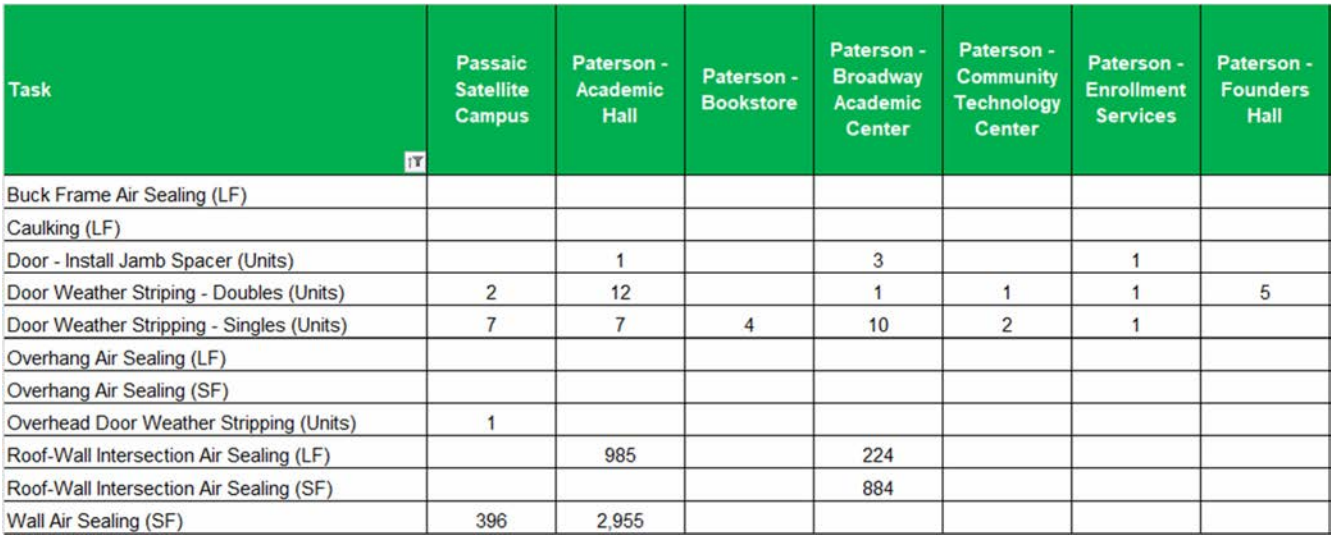
3) Building Envelope

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

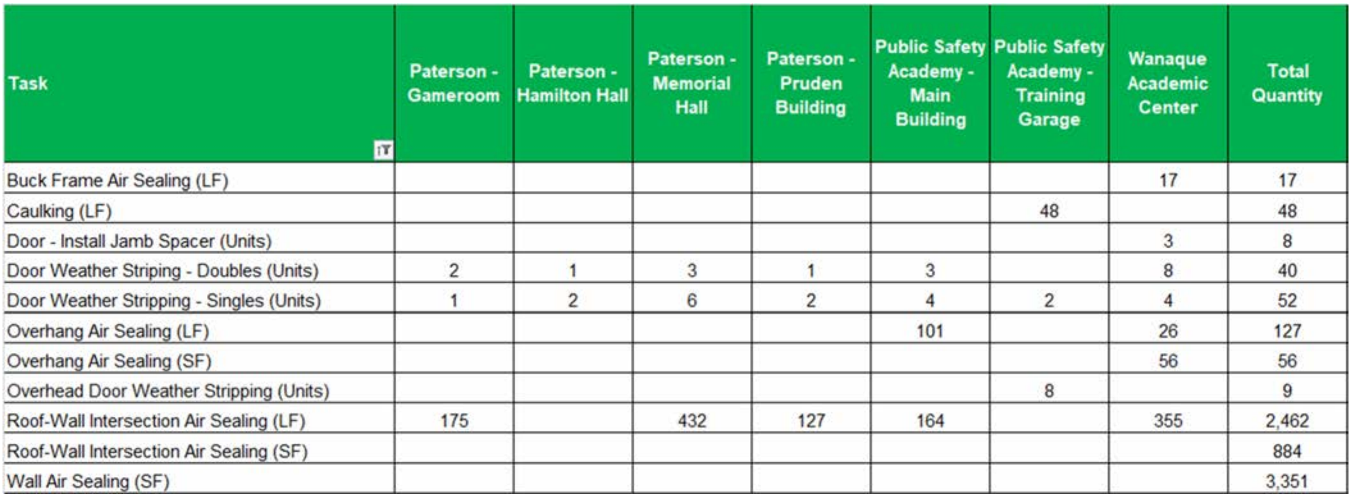
- Drafts will be reduced providing greater comfort for the building occupants. A tighter building envelope will lower the possibility of “hot” or “cold” spots brought on by unconditioned air infiltrating into conditioned spaces.
- Decreased Energy Consumption - Less conditioned air will be lost through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

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

- Attic Air Barrier Retrofit – There is no air barrier between the conditioned space and the vented area above the dropped ceiling. Fiberglass insulation alone does not stop air leakage. The air leakage reduces the effectiveness of the existing insulation.
    - Remove Existing Fiberglass – Fiberglass insulation in the bus garage is in very poor condition and should be removed to allow for full replacement with fresh, well performing insulation. As dirt and debris build up in fiberglass over time due to excessive air leakage thermal bridges reduce effectiveness of the insulation greatly reducing R-Value over time.
- Caulking – There are unsealed perimeter joints and holes found at the entryway assembly as indicated on the floor plans. Old sealants have failed at the intersection between the existing framing and wall allowing air to infiltrate and exfiltrate the building.
- Door Weather Stripping – Deteriorated weather-stripping materials, ineffective weather-stripping installation and daylight showing at the perimeter of door systems create direct pathways for unwanted infiltration/ exfiltration throughout the school district.
- Roof-Wall Intersection Air Sealing – The roof-wall intersection is regularly an area that allows unwanted air leakage through the building shell. Exterior flashing and finish details at this area are not constructed to stop air leakage (exterior flashings are for water control, not air control); unsealed exterior flashing details combine with interior gaps in the framing between the roof and wall assembly to allow infiltration/ exfiltration.



Task	Passaic Satellite Campus	Paterson - Academic Hall	Paterson - Bookstore	Paterson - Broadway Academic Center	Paterson - Community Technology Center	Paterson - Enrollment Services	Paterson - Founders Hall
Buck Frame Air Sealing (LF)							
Caulking (LF)							
Door - Install Jamb Spacer (Units)		1		3		1	
Door Weather Striping - Doubles (Units)	2	12		1	1	1	5
Door Weather Stripping - Singles (Units)	7	7	4	10	2	1	
Overhang Air Sealing (LF)							
Overhang Air Sealing (SF)							
Overhead Door Weather Stripping (Units)	1						
Roof-Wall Intersection Air Sealing (LF)		985		224			
Roof-Wall Intersection Air Sealing (SF)				884			
Wall Air Sealing (SF)	396	2,955					



Task	Paterson - Gameroom	Paterson - Hamilton Hall	Paterson - Memorial Hall	Paterson - Pruden Building	Public Safety Academy - Main Building	Public Safety Academy - Training Garage	Wanaque Academic Center	Total Quantity
Buck Frame Air Sealing (LF)							17	17
Caulking (LF)						48		48
Door - Install Jamb Spacer (Units)							3	8
Door Weather Striping - Doubles (Units)	2	1	3	1	3		8	40
Door Weather Stripping - Singles (Units)	1	2	6	2	4	2	4	52
Overhang Air Sealing (LF)					101		26	127
Overhang Air Sealing (SF)							56	56
Overhead Door Weather Stripping (Units)						8		9
Roof-Wall Intersection Air Sealing (LF)	175		432	127	164		355	2,462
Roof-Wall Intersection Air Sealing (SF)								884
Wall Air Sealing (SF)								3,351

4) Solar PV

On-site solar photovoltaic (PV) power generation is an alternative answer to the increasing demand for purchased energy. Moreover, solar PV uses a clean renewable energy source without emission impact on the environment. Schneider Electric provides a comprehensive turnkey solution for on-site solar power generation from design to startup, including engineering and monitoring services.

The following table shows the solar PV systems proposed as part of the ESP.

Site	Production W/O Clipping (kWH)	Clip Concern	Production with Clipping (kWh)
Academic	510,640	Yes	494,215
Passaic Academic	119,668	No	119,668
Hamilton Hall	41,740	Yes	38,056
PSA RNM (Carport)	530,861	No	530,861
PSA Behind Meter (Roof)	317,047	No	317,047
Firehouse(Inew)	69,320	Yes	69,320
Wanaque	669,648	No	669,648
Memorial	199,003	Yes	195,065
Academic Addition	74,361	Yes	69,372
Total	2,532,288		2,503,251

Solar interconnection agreements have been sent to PSEG and JCP&L and are awaiting approval. It is expected that PSEG will prevent export of power from the sites in downtown Paterson, NJ. Thus, the systems proposed are intended to not export to the grid.

Please see the appendix for helioscope reports for each site.

5) Boiler Replacement

The existing hot water boiler plant is at its end of useful life and would benefit from replacement with new, high efficiency boilers sized with overall operating efficiency in mind.

Condensing hot water boilers achieve much higher operating efficiencies (typically greater than 90%) than conventional boilers by condensing the water vapor in exhaust gases and thereby recovering latent heat that would have been wasted. Fuel consumption is greatly reduced in comparison to conventional boilers using this advanced technology. A new condensing boiler plant will consist of two, smaller-size, condensing boilers designed to operate together to efficiently meet part-load conditions as well as design peak loads.

In addition to replacing the boiler, a new air/dirt separator will be installed.

Figure 3. Existing HW boilers

New boilers will have a potential efficiency of 14-16% greater than the existing boilers.

The following highlights the key benefits of this solution:

- **Reduce Energy Consumption** – Matching the heating load more closely reduces fuel consumption.
- **Increase Boiler Efficiency** – Decreasing the amount of fuel used by the boilers, both during part- and full-load conditions, improves boiler plant efficiency.
- **Extends Equipment Life** – Minimizing boiler cycling with greater turndown ratios extends the expected life of existing boilers.
- **Improve Occupant Comfort** – Improving boiler turndown also helps to maintain consistent hot water supply temperatures for space occupants.

6) Chiller Replacement

The Paterson Academic & Founders Halls are served by a water-cooled chiller plant in the basement of Academic. One (1) of the existing chillers failed before 2020 and has been non-operational since. This scope of work will replace an existing centrifugal chiller with a new magnetic bearing water cooled chiller.

Magnetic bearing chillers typically utilize multi-stage centrifugal, variable speed compressors that levitate above their magnetic, oil-free bearings, freely rotating with a substantial reduction in energy losses due to friction. Chiller heat transfer efficiency is increased because no oil enters the evaporator or the condenser. The oil-free system also eliminates contamination of refrigerant, fouling of evaporator lines, and the need for oil-related maintenance and component power consumption, resulting in operations and maintenance savings. This technology improvement translates directly into more than 40% on average in electrical consumption and demand savings.

In addition to the efficiency, operations and maintenance improvements described above, oil-free magnetic bearing chillers utilize variable speed drives that allow the compressor to operate more efficiently at part-load conditions. In addition, the magnetic bearings and permanent magnet synchronous motor improve the chiller's resistance to power line disturbances, allowing the compressor to more easily ride through voltage drops and short duration power losses. No friction and less wear translate into reduced noise generation, increased reliability, and maximized equipment uptime.

Figure 4. Non-operational Chiller

The existing non-operational chiller will be replaced and become the primary chiller to cool the building.

The existing inoperable 200-ton centrifugal chiller will be replaced with a new magnetic bearing 200-ton chiller. Please see mechanical sketches for more information.

7) Gym Rooftop Unit Replacement (add AC)

The existing gymnasium is heated and ventilated via (2) RTUs. The RTUs are original to the building section and in need of being replaced. No air conditioning is currently available for students using the gymnasium causing comfort issues for events.

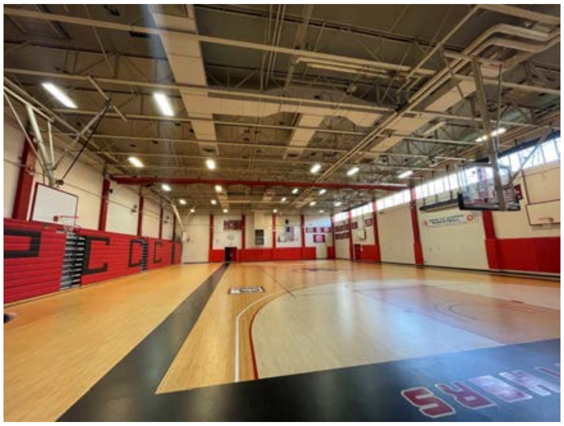


Figure 5. Gymnasium Floor

The gymnasium is not currently air conditioned.

Figure 6. Existing heating only RTU

Replacing the 1970s heating only equipment with DX cooling will reduce fan energy significantly.

The existing RTUs will be removed with new DX (with heat pump) RTUs with hot water coils will be installed. Please refer to the mechanical schematics in the appendix for information about this scope of work.

The following highlights the key benefits of this solution:

- **Reduce Energy Costs** – High efficiency equipment and improved control strategies will improve heating and cooling efficiency, thus lowering operating costs.
- **Reduce Maintenance** – New equipment will minimize maintenance calls currently experienced for aged and failing equipment.
- **Improve Occupant Comfort** – Equipment will operate more effectively to provide better building comfort.

9) Various HVAC Replacements

Many of the buildings have equipment that is aged past its expected life and would benefit from an upgrade. Provided on the following page is a summary of the HVAC being replaced as part of this project.

The following highlights the key benefits of this solution:

- **Reduce Energy Costs** – High efficiency equipment and improved control strategies will improve heating and cooling efficiency, thus lowering operating costs.
- **Reduce Maintenance** – New equipment will minimize maintenance calls currently experienced for aged and failing equipment.
- **Improve Occupant Comfort** – Equipment will operate more effectively to provide better building comfort.

Figure 7. Existing RTU at CTC

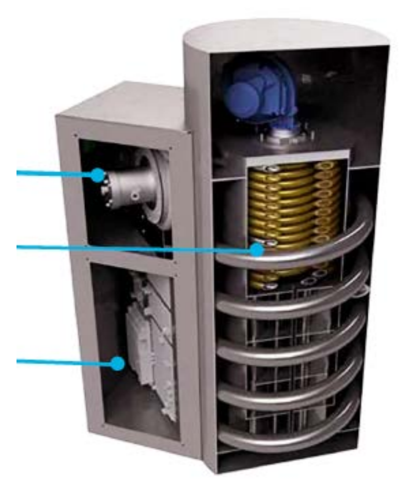
Many of the existing RTUs are aged and in need of replacement.

Building	Unit Tag	Proposed Unit Model	Description	NOMINAL COOLING CAPACITY (MBH)	IEER	EER	HEAT INPUT (MBH)	HEAT OUTPUT (MBH)	Thermal Efficiency
Game Room/Academic	RTU-1	KGC092S4M	7.5 TON PACKAGED RTU WITH NG HEAT.	92	14.6	11	180	144	80%
Game Room/Academic	RTU-2	KGC092S4M	7.5 TON PACKAGED RTU WITH NG HEAT.	92	14.6	11	180	144	80%
WANAQUE	AC-1	48FC*M12	10 TON PACKAGED RTU WITH NG HEAT.	118	11	11	250	205	82%
WANAQUE	AC-2	48FC*M14	12.5 TON PACKAGED RTU WITH NG HEAT.	132	10.2	10.2	250	205	82%
WANAQUE	AC-3	48FC*M14	12.5 TON PACKAGED RTU WITH NG HEAT.	132	10.2	10.2	250	205	82%
WANAQUE	AC-4	48FC*M08	7.5 TON PACKAGED RTU WITH NG HEAT.	86	15	11.2	224	181	81%
WANAQUE	AC-5	48FC*M14	12.5 TON PACKAGED RTU WITH NG HEAT.	132	10.2	10.2	250	205	82%
WANAQUE	AC-6	48FC*M07	6 TON PACKAGED RTU WITH NG HEAT.	70	15	11	150	120	80%
WANAQUE	AC-7	48FC*M16	15 TON PACKAGED RTU WITH NG HEAT.	174	10.8	10.8	350	284	81%
WANAQUE	AC-8	48FC*M08	7.5 TON PACKAGED RTU WITH NG HEAT.	86	15	11.2	224	181	81%
WANAQUE	AC-9	48FC*M16	15 TON PACKAGED RTU WITH NG HEAT.	174	10.8	10.8	350	284	81%
WANAQUE	AC-10	48FC*M12	10 TON PACKAGED RTU WITH NG HEAT.	118	11	11	250	205	82%
WANAQUE	AC-11	48FC*M14	12.5 TON PACKAGED RTU WITH NG HEAT.	132	10.2	10.2	250	205	82%
HAMILTON H.	RTU-1	50P7-0605404WBN98Y	60 TON RTU	720	13.7	10	NA	NA	NA
HAMILTON H.	-	MSY/MSU-GS18NA	3 TON SPLIT-SYSTEM	33.2		8.8	NA	NA	NA
HAMILTON H.	-	MSY/MSU-GS18NA	3 TON SPLIT-SYSTEM	33.2		8.8	NA	NA	NA
HAMILTON H.	-	MSY/MSU-GS18NA	3 TON SPLIT-SYSTEM	33.2		8.8	NA	NA	NA
HAMILTON H.	-	FTX500	500K BOILER	NA	NA	NA	500	489	98%
HAMILTON H.	-	FTX500	500K BOILER	NA	NA	NA	500	489	98%
HAMILTON C.	AC 2	14J03/10C50/19A33	2.5 TON SPLIT /W FURNACE	28.5		12.5	66	63.9	96%
HAMILTON C.	AC-3	12X57/10C58/19A35	4 TON SPLIT /W FURNACE	47.6		12.5	110	107.2	96%
HAMILTON C.	AC 1-1	24A96/10C58/96W29	7.5 TON SPLIT /W FURNCE	96.9	11.2	14.8	220	212	96%
HAMILTON C.	AC 1-2	24A96/10C59/96W30	7.5 TON SPLIT /W FURNACE	96.9	11.2	14.8	220	212	96%
HAMILTON C.	RTU-1	KGC150S4M	12.5 TON RTU WITH NG HEAT	154.3	14	10.8	240	194	81%
HAMILTON C.	RTU-3	KGC120S4M	10 TON RTU WITH NG HEAT	124.5	14.6	11	240	194	81%
HAMILTON C.	RTU-2	KGC092S4M	7.5 TON RTU WITH NG HEAT	95.1	14.6	11	240	194	81%
PSA	RTU -1	48A8S025CPM65AEQ	25 TON RTU W NG HEAT	300	13.1	9.8	350	283.5	81%
PSA	RTU -3	48A7S035CQM65AHT	35 TON RTU WITH NG HEAT	410	13.4	9.8	350	283.5	81%
PSA	-	PUY-A36NKA7(-BS)	3 TON SPLIT-SYSTEM	36		10.8	NA	NA	NA
PSA	-	PUY-A36NKA7(-BS)	3 TON SPLIT-SYSTEM	36		10.8	NA	NA	NA
PSA	-	PUY-A36NKA7(-BS)	3 TON SPLIT-SYSTEM	36		10.8	NA	NA	NA
PSA	-	PUY-A24NHA7(-BS)	2 TON SPLIT-SYSTEM	24		12.2	NA	NA	NA
PSA	-	PUY-A24NHA7(-BS)	2 TON SPLIT-SYSTEM	24		12.2	NA	NA	NA
CTC	RTU-1	KGC150S4M	12.5 TON RTU WITH NG HEAT	154.3	14	10.8	240	194	81%
CTC	RTU-2	KGC150S4M	12.5 TON RTU WITH NG HEAT	154.3	14	10.8	240	194	81%
CTC	RTU-3	KGC120S4M	10 TON RTU WITH NG HEAT	124.5	14.6	11	180	144	80%
BAS	RTU-1	KGC092S4M	5 TON RTU WITH NG HEAT	95.1	14.6	11	240	194	81%
BAS	RTU-2	KGC092S4M	5 TON RTU WITH NG HEAT	95.1	14.6	11	240	194	81%
BAS	RTU-3	KGC092S4M	5 TON RTU WITH NG HEAT	95.1	14.6	11	240	194	81%
BAS	RTU-4	KGB060S4B	7.5 TON RTU WITH NG HEAT	64	14	11	150	120	80%
BAS	RTU-5	KGB060S4B	7.5 TON RTU WITH NG HEAT	64	14	11	150	120	80%
BAS	RTU-6	KGB060S4B	7.5 TON RTU WITH NG HEAT	64	14	11	150	120	80%
PRUDEN	AC AH 1	ML14XC1-059-230/EL196UH110XE60C	3 TON SPLIT-SYSTEM /W FURNACE	57.9		12.5	110	107.2	96%
PRUDEN	AC AH 2	ML14XC1-059-230/EL196UH110XE60C	3 TON SPLIT-SYSTEM /W FURNACE	57.9		12.5	110	107.2	96%
PRUDEN	RTU-1	KGB060S4B	5 TON RTU WITH NG HEAT	64		11	150	120	80%
PRUDEN	RTU-2	KGB060S4B	5 TON RTU WITH NG HEAT	64		11	150	120	80%
PRUDEN	RTU-3	KGC120S4M	10 TON RTU WITH NG HEAT	124.5		11	240	194	81%
ESSC	RTU-1	MPS035F	35 TON RTU WITH NG HEAT	391.7	13	10.1	600	486	81%
ESSC	RTU-2	DPS016A	15 TON PACKAGED RTU WITH NG HEAT.	192.2	20.5	11.7	600	480	80%
ESSC	RTU-3	DPS016A	15 TON PACKAGED RTU WITH NG HEAT.	192.2	20.5	11.7	600	480	80%
ESSC	RTU-4	DPS016A	17 TON PACKAGED RTU WITH NG HEAT.	192.2	20.5	11.7	600	480	80%
ESSC	RTU-5	DPS016A	17 TON PACKAGED RTU WITH NG HEAT.	192.2	20.5	11.7	600	480	80%
ESSC	RTU-6	MPSA04D	4 TON PACKAGED RTU WITH NG HEAT.	48.8		11.2	120	97.2	81%

10) Combined Heat and Power

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

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



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

The basis of design for this equipment is a the SmartWatt Boiler SW300-6. The mCHP will operate as a first stage of heat for the academic complex from October 1st through end of March. Please see Appendix 7.2 Preliminary Mechanical Sketches for more detail on the scope of work.

11) Hamilton Hall Electrical Upgrade

Building electrical distribution systems are often forgotten and neglected after a building is constructed. These systems are often left alone unless power needs to be interrupted to service the end load or if the building is being modified as part of a remodel effort. Over time, loads change and the condition of the switchgear degrades due to corrosion and other factors, rendering them unable to even perform the rare switching for service. When the actual switchgear does need to be maintained, parts are hard to find because new parts often will not fit in older panels. Further, when systems get modified, drawings are not edited to reflect these changes so great dependence is placed upon the maintenance personnel who made the changes. Eventually, the system will degrade to a point where it becomes hazardous to operate, and the entire system will need to be upgraded to current technology.

Upgrading distribution switchgear normally does not result in significant energy savings. The primary driver for this scope of work is improved reliability for the building. Such a replacement will often enable the operational team to maintain the new system and will often cause a reduction in expenditure on hard-to-find parts.

Figure 8. Existing Hamilton Hall Electrical

Electrical switchgear requires replacement as systems degrade.

Scope

Remove existing switchboard and provide and install new 1000 Amp switchboard in basement electrical room. Please refer to the appendix for preliminary design.

Impact

The following highlights the key benefits of this solution:

- **Improve Operations** – Improve maintenance and allow for load switching in the future.
- **Metering Feedback** – New systems typically have metering functionality built into them allowing the operational team to better understand the electrical load distribution.
- **Right Sized Equipment** – Replacement allows for equipment to be sized for known, existing conditions.

12) Window Replacement: Academic South and West Facade

Replacing existing double-pane, aluminum framed windows will reduce infiltration, decrease heating and cooling loads, and improve building pressurization. New, high-performance windows will also provide a better thermal barrier and improve the building's exterior aesthetics, while continuing to provide clear views and daylighting for occupants. Energy savings are achieved by a reduction in conductive heat gains through better window heat transfer resistance (U-values), decreased solar heat gain from the use of new, low emissivity (low-E) glass, and less air infiltration with tighter fenestration seals. Adding frit will also reduce the solar heat gain occurring on the South and West facades.

Please see Appendix 7.5 Preliminary Window Design for more detail on the scope of work.

Figure 9. Exterior Window

The corner of the facility will need improved to reduce wear and tear.

Impact

The following highlights the key benefits of this solution:

- **Reduce Energy Costs** – Improving the thermal performance of the windows reduces energy consumption required for heating and cooling and the resultant carbon footprint.
- **Improve Occupant Comfort** – Eliminating undesirable air drafts and heat loss by replacing leaky windows improves occupant comfort and interior space temperature control.
- **Improve Building Aesthetics** – New windows can have a significant and positive impact on the aesthetics of a building's exterior.
- **Maintenance** – the existing windows are able to overextend and put extra stress on hinges that then may fail causing a maintenance issue in closing the windows. New windows will not extend beyond 4" inches to prevent excess wear on hinges.

3.2 Optional ECMs

The following opportunities were identified and investigated during the Investment Grade Audit.

1. **Wanaque Split Systems** – The existing split systems serving the library are aged and should be replaced.
2. **Academic Hydronic heating and cooling pumps** – The pumps for the chilled water system are original and given their age should be replaced.
3. **Wanaque Remote Net Metering Solar** – the Wanaque campus has significant property that could be used to remote net meter solar to other government JCPL accounts. Given the length of negotiating these agreements, this has not been included at this time.
4. **Academic RTUs** – The (4) RTUs in Academic and the (3) split systems in Academic Addition are aged and may require replacement.
5. **Academic AHUs** – the existing basement AHUs are original to the building and past their expected life. Replacing these AHUs with new systems will reduce energy usage.
6. **Founders AHUs** – The founders AHUs vary in age with some being over 30 years old.
7. **Founders RTUs** – The existing RTUs serving the spline, theater and locker rooms are original to the building and would benefit from replacement.
8. **Battery Storage** – the NJ Straw proposal for battery storage is expected soon. Battery Energy Storage Systems (BESS) may make sense depending on available incentives from NJ BPU.
9. **Replace Domestic Water Heaters –** Replacement of water heaters with heat pump water heaters could reduce fossil fuel usage and benefit the college.
10. **Air Balancing TAB –** a building-wide airside test, adjust, and balance scope could benefit some of the older buildings to help reduce hot/cold areas during the winter and summer months. This scope would work well if performed in conjunction with any HVAC replacement project.
11. **Water Conservation Measures** – Water fixtures at the buildings are a mix of low flow and older higher flow and could benefit from recommissioning or replacement, however savings is not sufficient to cover the cost to perform such upgrades.
12. **Secondary Transformers –** The step-up transformer for the academic chiller/boiler could benefit from being replaced. This scope should be included when the replacement of the second chiller is conducted.
13. **Window Replacements** – Some windows in the College are older windows that are in poor shape. These should be addressed as part of future capital projects.

4.0 Energy Savings

4.1 Baseline Energy Use

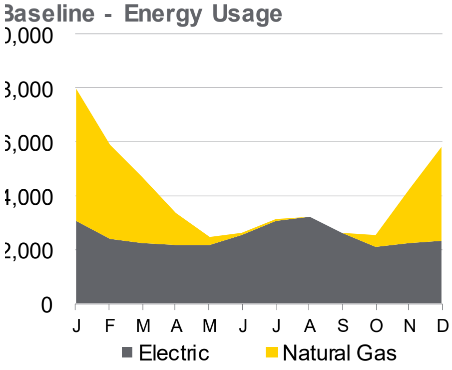
This baseline includes all facilities and was created by taking several years of utility data and utilizing the following:

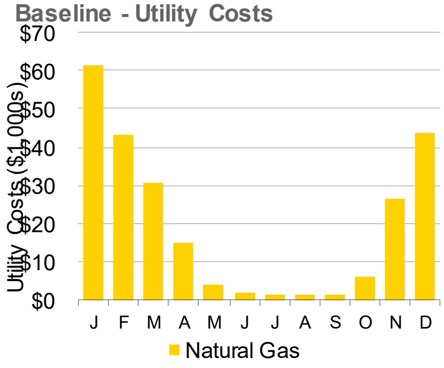
- Prorating the usage into clean monthly bins
- Weather normalizing the baseline to represent a typical meteorological year

Passaic County Community College - All Sites - Baseline

	Electricity		Natural Gas		Total	
Month *mmm*	Energy Use *kWh*	Energy Demand *kW*	Energy Use *Therm*	Cost *$*	Energy Use *MMBtu*	Cost *$*
Jan	893,908	1,738	49,649	$61,345	8,016	$161,097
Feb	708,880	1,834	34,622	$42,930	5,882	$124,764
Mar	668,177	1,683	24,635	$30,612	4,744	$107,826
Apr	642,815	1,625	11,761	$15,073	3,370	$89,979
May	643,309	1,933	2,557	$3,938	2,451	$80,219
Jun	742,557	2,090	864	$1,927	2,621	$106,267
Jul	900,849	2,253	460	$1,449	3,121	$124,067
Aug	940,406	2,205	471	$1,461	3,257	$127,105
Sept	762,786	1,927	395	$1,423	2,643	$105,349
Oct	620,764	1,618	4,483	$6,210	2,567	$79,048
Nov	650,673	1,617	20,651	$26,324	4,286	$102,043
Dec	681,673	1,586	34,964	$43,778	5,823	$123,095
Year	**8,856,797**	**22,111**	**185,512**	**$236,471**	**48,779**	**$1,330,860**

	Electricity		Natural Gas		Total	
Indices	**kBtu/sf**	**W/sf**	**kBtu/sf**	**$/sf**	**kBtu/sf**	**$/sf**
	54.0	**4.0**	**33.1**	**$0.42**	**87.1**	**$2.38**





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

Academic Complex

	Electricity		Natural Gas		Total	
Month	Energy Use	Energy Demand	Energy Use	Cost	Energy Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*	*MMBtu*	*$*
Jan	330,152	506	27,083	$31,069	3,835	$67,176
Feb	244,776	505	18,112	$20,812	2,647	$48,284
Mar	233,457	471	13,342	$15,341	2,131	$41,542
Apr	183,219	440	5,270	$6,108	1,152	$27,116
May	239,099	556	432	$640	859	$27,831
Jun	301,990	643	347	$553	1,065	$40,405
Jul	370,934	715	358	$564	1,302	$48,570
Aug	357,243	729	364	$570	1,256	$47,395
Sept	292,313	652	0	$196	998	$39,391
Oct	219,000	522	1,062	$1,289	854	$26,345
Nov	207,176	532	10,432	$12,118	1,750	$35,973
Dec	230,200	486	18,019	$20,798	2,588	$46,817
Year	**3,209,558**	**6,757**	**94,822**	**$110,058**	**20,436**	**$496,845**

Hamilton Hall

	Electricity		Natural Gas		Total	
Month	Energy Use	Energy Demand	Energy Use	Cost	Energy Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*	*MMBtu*	*$*
Jan	23,194	45	1,607	$2,326	240	$5,232
Feb	22,086	59	1,305	$1,890	206	$4,747
Mar	25,054	66	1,004	$1,453	186	$4,644
Apr	24,824	69	459	$668	131	$3,849
May	27,391	66	81	$128	102	$3,555
Jun	28,015	67	19	$45	97	$4,142
Jul	34,762	75	0	$20	119	$4,899
Aug	35,211	76	1	$21	120	$4,962
Sept	32,403	78	0	$20	111	$4,705
Oct	27,501	69	133	$198	107	$3,653
Nov	23,756	70	569	$839	138	$3,922
Dec	25,374	56	1,131	$1,650	200	$4,835
Year	**329,570**	**796**	**6,307**	**$9,258**	**1,756**	**$53,144**

Wanaque Academic Complex

	Electricity		Natural Gas		Total	
Month	Energy Use	Energy Demand	Energy Use	Cost	Energy Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*	*MMBtu*	*$*
Jan	157,442	280	8,980	$10,306	1,435	$26,550
Feb	109,727	214	7,089	$8,150	1,083	$19,636
Mar	96,374	201	4,717	$5,423	801	$15,616
Apr	71,226	199	2,696	$3,115	513	$11,016
May	71,132	238	974	$1,177	340	$9,393
Jun	73,373	234	213	$395	272	$8,886
Jul	86,684	264	0	$176	296	$10,102
Aug	102,917	261	0	$176	351	$11,547
Sept	86,180	264	164	$345	311	$10,230
Oct	57,359	248	1,338	$1,557	330	$8,592
Nov	75,925	208	4,232	$5,004	682	$13,415
Dec	36,435	231	7,354	$8,576	860	$13,614
Year	**1,024,773**	**2,843**	**37,756**	**$44,400**	**7,273**	**$158,595**

Hamilton Club

	Electricity		Natural Gas		Total	
Month	Energy Use	Energy Demand	Energy Use	Cost	Energy Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*	*MMBtu*	*$*
Jan	4,682	58	2,554	$3,683	271	$4,464
Feb	4,947	26	1,153	$1,660	132	$2,321
Mar	5,326	19	700	$1,004	88	$1,674
Apr	19,936	23	454	$649	113	$2,913
May	8,223	35	42	$76	32	$1,135
Jun	4,439	46	10	$33	16	$1,189
Jul	23,287	54	11	$35	81	$3,337
Aug	19,830	55	11	$35	69	$2,989
Sept	12,420	49	19	$45	44	$2,111
Oct	7,798	31	253	$359	52	$1,351
Nov	9,864	73	1,003	$1,465	134	$2,874
Dec	9,130	34	1,454	$2,118	177	$3,270
Year	**129,880**	**504**	**7,664**	**$11,160**	**1,210**	**$29,629**

Public Safety Academy

	Electricity		Natural Gas		Total	
	Energy	Energy	Energy		Energy	
Month	Use	Demand	Use	Cost	Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*	*MMBtu*	*$*
Jan	61,658	166	2,748	$3,906	485	$11,211
Feb	55,876	157	2,365	$3,357	427	$10,046
Mar	46,095	142	1,986	$2,801	356	$8,442
Apr	39,261	123	1,372	$1,916	271	$6,787
May	42,458	111	749	$1,024	220	$6,164
Jun	46,647	128	184	$266	178	$7,042
Jul	54,684	141	29	$59	190	$7,817
Aug	55,658	140	32	$62	193	$7,906
Sept	44,456	118	155	$227	167	$6,661
Oct	40,196	104	847	$1,156	222	$6,041
Nov	39,392	100	1,766	$2,568	311	$7,353
Dec	43,810	97	2,778	$4,032	427	$9,251
Year	**570,191**	**1,527**	**15,010**	**$21,373**	**3,447**	**$94,722**

Community Tech Center

	Electricity		Natural Gas		Total	
	Energy	Energy	Energy		Energy	
Month	Use	Demand	Use	Cost	Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*	*MMBtu*	*$*
Jan	16,020	45	1,316	$1,909	186	$3,855
Feb	14,246	70	847	$1,231	133	$3,101
Mar	13,829	40	260	$385	73	$2,071
Apr	13,387	32	135	$205	59	$1,806
May	6,040	52	21	$48	23	$947
Jun	14,977	57	26	$54	54	$2,507
Jul	23,416	57	22	$50	82	$3,417
Aug	20,368	36	34	$65	73	$2,796
Sept	18,155	51	20	$47	64	$2,756
Oct	18,322	52	93	$144	72	$2,374
Nov	17,527	52	444	$659	104	$2,800
Dec	17,073	46	797	$1,169	138	$3,235
Year	**193,359**	**591**	**4,013**	**$5,965**	**1,061**	**$31,664**

Broadway Academic

	Electricity		Natural Gas		Total	
Month	Energy Use	Energy Demand	Energy Use	Cost	Energy Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*	*MMBtu*	*$*
Jan	11,455	34	2,240	$3,324	263	$4,776
Feb	7,703	30	1,718	$2,574	198	$3,601
Mar	8,681	27	1,417	$2,137	171	$3,257
Apr	29,748	31	821	$1,286	184	$4,701
May	11,051	117	189	$396	57	$2,192
Jun	13,365	131	14	$157	47	$3,565
Jul	15,346	120	3	$143	53	$3,598
Aug	12,002	113	2	$142	41	$3,143
Sept	13,338	127	6	$147	46	$3,489
Oct	10,716	55	452	$745	82	$2,214
Nov	7,940	34	1,162	$1,814	143	$2,887
Dec	9,068	37	1,653	$2,520	196	$3,727
Year	**150,412**	**858**	**9,678**	**$15,385**	**1,481**	**$41,150**

Pruden Building

	Electricity		Natural Gas		Total	
Month	Energy Use	Energy Demand	Energy Use	Cost	Energy Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*	*MMBtu*	*$*
Jan	12,868	56	1,464	$2,115	190	$3,771
Feb	8,199	234	996	$1,439	128	$3,422
Mar	9,078	234	626	$904	94	$2,982
Apr	8,785	234	311	$451	61	$2,498
May	9,078	234	43	$78	35	$2,156
Jun	8,785	234	4	$26	30	$4,387
Jul	9,078	234	0	$20	31	$4,413
Aug	9,076	202	0	$20	31	$3,938
Sept	8,618	31	2	$23	30	$1,411
Oct	7,416	23	175	$255	43	$1,167
Nov	7,120	21	527	$779	77	$1,653
Dec	8,306	42	844	$1,236	113	$2,332
Year	**106,406**	**1,781**	**4,992**	**$7,344**	**862**	**$34,131**

Passaic Academic Center

	Electricity		Natural Gas		Total	
Month	Energy Use	Energy Demand	Energy Use	Cost	Energy Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*	*MMBtu*	*$*
Jan	78,786	157	0	$20	269	$9,003
Feb	69,363	150	1	$21	237	$8,029
Mar	60,806	131	1	$21	208	$7,087
Apr	101,196	129	1	$21	345	$11,133
May	46,013	117	0	$20	157	$5,543
Jun	47,716	107	0	$20	163	$6,628
Jul	59,831	138	1	$21	204	$8,265
Aug	106,750	138	0	$20	364	$12,968
Sept	54,566	131	0	$20	186	$7,642
Oct	51,470	133	0	$20	176	$6,168
Nov	54,038	128	0	$20	184	$6,401
Dec	70,459	146	23	$53	243	$8,163
Year	**800,993**	**1,604**	**27**	**$277**	**2,737**	**$97,029**

Memorial Hall

	Electricity		Natural Gas		Total	
Month	Energy Use	Energy Demand	Energy Use	Cost	Energy Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*	*MMBtu*	*$*
Jan	171,984	320	56	$117	593	$19,183
Feb	147,804	316	28	$78	507	$16,699
Mar	145,289	281	9	$52	497	$16,265
Apr	127,653	270	7	$50	436	$14,445
May	153,868	304	3	$44	525	$17,224
Jun	168,730	314	25	$72	578	$21,604
Jul	184,006	318	11	$54	629	$23,175
Aug	184,143	315	3	$44	629	$23,129
Sept	169,218	306	8	$50	578	$21,522
Oct	155,279	278	5	$46	530	$17,258
Nov	150,785	300	14	$60	516	$16,918
Dec	166,134	301	30	$82	570	$18,489
Year	**1,924,893**	**3,624**	**199**	**$750**	**6,590**	**$225,912**

Enrollment and Student Services Center

	Electricity		Natural Gas		Total	
Month *mmm*	Energy Use *kWh*	Energy Demand *kW*	Energy Use *Therm*	Cost *$*	Energy Use *MMBtu*	Cost *$*
Jan	22,918	65	1,531	$2,218	231	$5,184
Feb	21,760	66	1,000	$1,451	174	$4,309
Mar	21,605	63	564	$822	130	$3,654
Apr	21,164	66	219	$325	94	$3,126
May	26,663	89	0	$20	91	$3,475
Jun	31,928	109	0	$20	109	$5,075
Jul	34,943	121	0	$20	119	$5,531
Aug	36,403	125	0	$20	124	$5,741
Sept	31,089	104	0	$20	106	$4,925
Oct	25,015	84	105	$161	96	$3,433
Nov	22,982	73	494	$732	128	$3,755
Dec	23,170	63	872	$1,277	166	$4,271
Year	**319,642**	**1,029**	**4,786**	**$7,087**	**1,570**	**$52,480**

Institute for New and Emerging Workforce

	Electricity		Natural Gas		Total	
Month *mmm*	Energy Use *kWh*	Energy Demand *kW*	Energy Use *Therm*	Cost *$*	Energy Use *MMBtu*	Cost *$*
Jan	1,029	1	0	$176	4	$296
Feb	912	1	0	$176	3	$283
Mar	958	1	0	$176	3	$288
Apr	886	1	0	$176	3	$280
May	301	1	0	$176	1	$217
Jun	158	1	0	$176	1	$210
Jul	170	1	0	$176	1	$211
Aug	158	1	0	$176	1	$210
Sept	30	1	0	$176	0	$196
Oct	693	5	0	$176	2	$278
Nov	32,997	19	0	$176	113	$3,834
Dec	38,042	41	0	$176	130	$4,482
Year	**76,333**	**72**	**0**	**$2,111**	**261**	**$10,785**

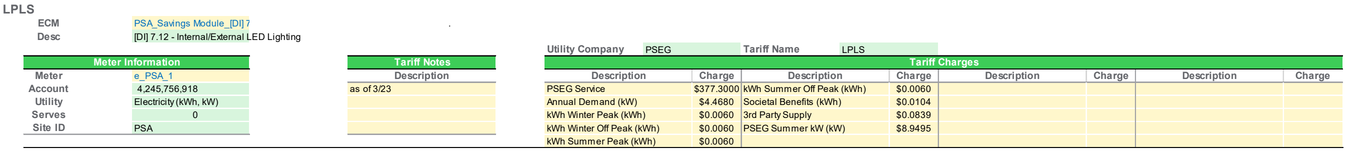
Zendell Hall

	Electricity		Natural Gas		Total	
Month	Energy Use	Energy Demand	Energy Use	Cost	Energy Use	Cost
mmm	*kWh*	*kW*	*Therm*	*$*	*MMBtu*	*$*
Jan	1,720	6	70	$177	13	$398
Feb	1,481	6	8	$91	6	$285
Mar	1,626	6	10	$93	7	$303
Apr	1,530	8	17	$102	7	$308
May	1,992	12	24	$112	9	$387
Jun	2,435	17	23	$110	11	$627
Jul	3,709	15	25	$113	15	$732
Aug	648	14	23	$110	4	$382
Sept	0	14	21	$107	2	$310
Oct	0	14	19	$105	2	$174
Nov	1,173	7	9	$92	5	$257
Dec	4,472	6	8	$91	16	$609
Year	**20,785**	**125**	**258**	**$1,303**	**97**	**$4,773**

4.2 Energy Rates

Provided below is a chart all utility accounts identified by building with associated rates and a breakdown of the associated utility rate sims.

Building	Meter	Meter Type	Tariff Name
Academic Hall			
	e_AH_1	Electricity (kWh, kW)	LPLS
	e_AH_2	Electricity (kWh, kW)	LPLS
	e_Game Room_1	Electricity (kWh, kW)	LPLS
	ng_AH_1	Natural Gas (Therm, Therm/hr)	GSG (HTG)
	ng_AH_2	Natural Gas (Therm, Therm/hr)	LVG
Broadway Academic Center			
	e_BAS_1	Electricity (kWh, kW)	GLP
	e_BAS_10	Electricity (kWh, kW)	GLP
	e_BAS_11	Electricity (kWh, kW)	GLP
	e_BAS_2	Electricity (kWh, kW)	GLP
	e_BAS_3	Electricity (kWh, kW)	GLP
	e_BAS_4	Electricity (kWh, kW)	GLP
	e_BAS_5	Electricity (kWh, kW)	GLP
	e_BAS_6	Electricity (kWh, kW)	GLP
	e_BAS_7	Electricity (kWh, kW)	GLP
	e_BAS_8	Electricity (kWh, kW)	GLP
	e_BAS_9	Electricity (kWh, kW)	GLP
	ng_BAS_1	Natural Gas (Therm, Therm/hr)	GSG (HTG)
	ng_BAS_2	Natural Gas (Therm, Therm/hr)	GSG (HTG)
	ng_BAS_3	Natural Gas (Therm, Therm/hr)	GSG (HTG)
	ng_BAS_4	Natural Gas (Therm, Therm/hr)	GSG (HTG)
	ng_BAS_5	Natural Gas (Therm, Therm/hr)	GSG (HTG)
	ng_BAS_6	Natural Gas (Therm, Therm/hr)	GSG (HTG)
	ng_BAS_7	Natural Gas (Therm, Therm/hr)	GSG (HTG)
	CTC		
	e_CTC_1	Electricity (kWh, kW)	GLP
	ng_CTC_1	Natural Gas (Therm, Therm/hr)	GSG (HTG)
Enrollment & Student Services Center			
	e_ESSC_1	Electricity (kWh, kW)	LPLS
	ng_ESSC_1	Natural Gas (Therm, Therm/hr)	GSG (HTG)
Hamilton Club			
	e_HC_1	Electricity (kWh, kW)	GLP
	ng_HC_1	Natural Gas (Therm, Therm/hr)	GSG (HTG)
Hamilton Hall			
	e_HH_1	Electricity (kWh, kW)	GLP
	ng_HH_1	Natural Gas (Therm, Therm/hr)	GSG
	INEW		
	e_INEW_1	Electricity (kWh, kW)	GLP
	ng_INEW_1	Natural Gas (Therm, Therm/hr)	LVG
Memorial Hall			
	e_MH_1	Electricity (kWh, kW)	LPLS
	e_MH_2	Electricity (kWh, kW)	LPLS
	ng_MH_1	Natural Gas (Therm, Therm/hr)	GSG (HTG)
	ng_MH_2	Natural Gas (Therm, Therm/hr)	GSG (HTG)
Passiac Academic Center			
	e_PAC_1	Electricity (kWh, kW)	LPLS
	ng_PAC_1	Natural Gas (Therm, Therm/hr)	GSG (HTG)
Pruden Building			
	e_PB_1	Electricity (kWh, kW)	GLP
	ng_PB_1	Natural Gas (Therm, Therm/hr)	GSG (HTG)
Public Safety Academy			
	e_PSA_1	Electricity (kWh, kW)	LPLS + BPL
	ng_PSA_1	Natural Gas (Therm, Therm/hr)	GSG (HTG)
Wanaque Academic Center			
	e_WAC_1	Electricity (kWh, kW)	JCPL
	e_WAC_2	Electricity (kWh, kW)	JCPL
	ng_WAC_1	Natural Gas (Therm, Therm/hr)	PSEG + Direct Energy
Zendell Hall			
	e_ZH_1	Electricity (kWh, kW)	GLP
	ng_ZH_1	Natural Gas (Therm, Therm/hr)	GSG (HTG)
	ng_ZH_2	Natural Gas (Therm, Therm/hr)	GSG
	ng_ZH_3	Natural Gas (Therm, Therm/hr)	GSG (HTG)
	ng_ZH_4	Natural Gas (Therm, Therm/hr)	GSG (HTG)



LPLS

ECM PSA_Savings Module_[DI] 7

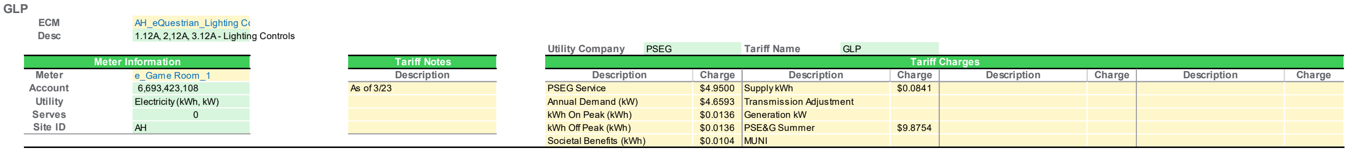
Desc [DI] 7.12 - Internal/External LED Lighting

Meter Information	
Meter	e_PSA_1
Account	4,245,756,918
Utility	Electricity (kWh, kW)
Serves	0
Site ID	PSA

Tariff Notes
Description
as of 3/23

Utility Company PSEG Tariff Name LPLS

Tariff Charges							
Description	Charge	Description	Charge	Description	Charge	Description	Charge
PSEG Service	$377.3000	kWh Summer Off Peak (kWh)	$0.0060				
Annual Demand (kW)	$4.4680	Societal Benefits (kWh)	$0.0104				
kWh Winter Peak (kWh)	$0.0060	3rd Party Supply	$0.0839				
kWh Winter Off Peak (kWh)	$0.0060	PSEG Summer kW (kW)	$8.9495				
kWh Summer Peak (kWh)	$0.0060						



GLP

ECM AH_eQuestrian_Lighting Cc

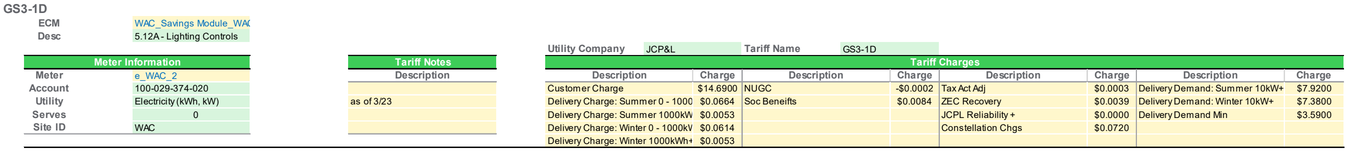
Desc 1.12A, 2,12A, 3.12A - Lighting Controls

Meter Information	
Meter	e_Game Room_1
Account	6,693,423,108
Utility	Electricity (kWh, kW)
Serves	0
Site ID	AH

Tariff Notes
Description
As of 3/23

Utility Company PSEG Tariff Name GLP

Tariff Charges							
Description	Charge	Description	Charge	Description	Charge	Description	Charge
PSEG Service	$4.9500	Supply kWh	$0.0841				
Annual Demand (kW)	$4.6593	Transmission Adjustment					
kWh On Peak (kWh)	$0.0136	Generation kW					
kWh Off Peak (kWh)	$0.0136	PSE&G Summer	$9.8754				
Societal Benefits (kWh)	$0.0104	MUNI					



GS3-1D

ECM WAC_Savings Module_WAC

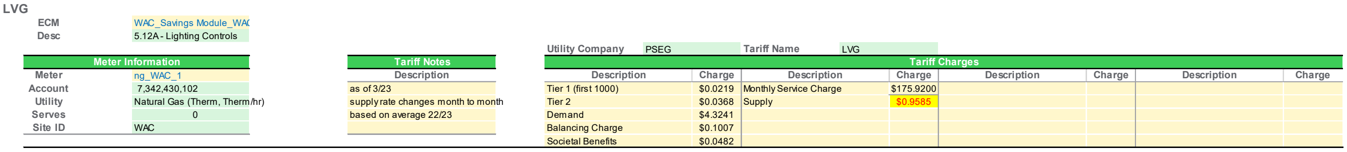
Desc 5.12A - Lighting Controls

Meter Information	
Meter	e_WAC_2
Account	100-029-374-020
Utility	Electricity (kWh, kW)
Serves	0
Site ID	WAC

Tariff Notes
Description
as of 3/23

Utility Company JCP&L Tariff Name GS3-1D

Tariff Charges							
Description	Charge	Description	Charge	Description	Charge	Description	Charge
Customer Charge	$14.6900	NUGC	-$0.0002	Tax Act Adj	$0.0003	Delivery Demand: Summer 10kW+	$7.9200
Delivery Charge: Summer 0 - 1000	$0.0664	Soc Beneifts	$0.0084	ZEC Recovery	$0.0039	Delivery Demand: Winter 10kW+	$7.3800
Delivery Charge: Summer 1000kW	$0.0053			JCPL Reliability +	$0.0000	Delivery Demand Min	$3.5900
Delivery Charge: Winter 0 - 1000kV	$0.0614			Constellation Chgs	$0.0720		
Delivery Charge: Winter 1000kWh+	$0.0053						



LVG

ECM WAC_Savings Module_WAC

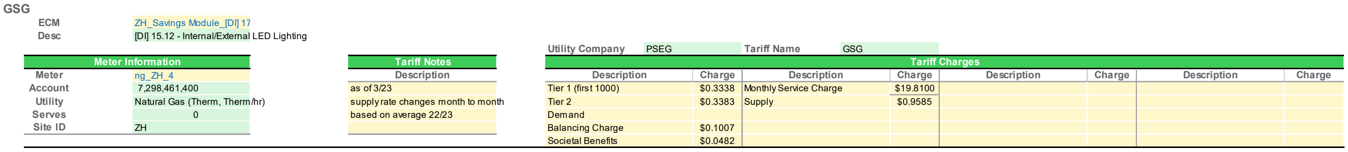
Desc 5.12A - Lighting Controls

Meter Information	
Meter	ng_WAC_1
Account	7,342,430,102
Utility	Natural Gas (Therm, Therm/hr)
Serves	0
Site ID	WAC

Tariff Notes
Description
as of 3/23
supply rate changes month to month
based on average 22/23

Utility Company PSEG Tariff Name LVG

Tariff Charges							
Description	Charge	Description	Charge	Description	Charge	Description	Charge
Tier 1 (first 1000)	$0.0219	Monthly Service Charge	$175.9200				
Tier 2	$0.0368	Supply	$0.9585				
Demand	$4.3241						
Balancing Charge	$0.1007						
Societal Benefits	$0.0482						



GSG

ECM ZH_Savings Module_[DI] 17

Desc [DI] 15.12 - Internal/External LED Lighting

Meter Information	
Meter	ng_ZH_4
Account	7,298,461,400
Utility	Natural Gas (Therm, Therm/hr)
Serves	0
Site ID	ZH

Tariff Notes
Description
as of 3/23
supply rate changes month to month
based on average 22/23

Utility Company PSEG Tariff Name GSG

Tariff Charges							
Description	Charge	Description	Charge	Description	Charge	Description	Charge
Tier 1 (first 1000)	$0.3338	Monthly Service Charge	$19.8100				
Tier 2	$0.3383	Supply	$0.9585				
Demand							
Balancing Charge	$0.1007						
Societal Benefits	$0.0482						

4.3 Energy Savings

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

Regarding non-energy savings, maintenance savings are broken down between the following two categories:
1. Lighting – O&M savings were derived from PCCC's 2022 and 2021 lighting material spend.
2. Mechanical – O&M savings were derived from PCCC's 2022 and 2021 HVAC RTU repair spend and prorated based on the number of RTUs the ESIP program is replacing.

For detailed savings calculations for each ECM, please see the Appendix 7.1 Savings Calculations & Documentation and Appendix 7.1 Box Folder.

ECM Savings Summary by Site

ECM Detail			Total Cost Savings	Detail Unit Savings			Detailed Cost Savings	
Site	ECM	Hard Cost	Cost Savings	Electric	Electric	Natural Gas	Electric	Natural Gas
Name	*Name*	*$*	*$*	*kWh*	*kW*	*Therm*	*$*	*$*
AH	Gym AHU Replacement	$ 713,025	$7,715	48,051	-80.2	3,560	$3,657	$4,058
AH	Chiller Replacement (1x)	$ 1,227,349	$21,466	180,777	335.1	0	$21,466	$0
AH	Boiler Upgrade	$ 1,769,639	$9,678	-939	-0.2	8,705	-$95	$9,774
AH	Facility Scheduling	$ 41,348	$67,494	388,822	-79.4	25,791	$38,244	$29,251
AH	Smart Watt CHP	$ 235,199	$2,110	18,984	36.0	0	$2,110	$0
AH	Building Envelope	$ 39,932	$5,464	1,546	0.0	4,663	$159	$5,305
AH	Building Envelope	$ 39,932	$1,137	280	0.0	974	$29	$1,108
AH	Building Envelope	$ 3,634	$809	223	0.0	691	$23	$786
AH	Window Replacement	$ 1,292,389	$2,405	2,867	0.0	1,854	$295	$2,109
AH	Internal/External LED Lighting	$ 645,340	$30,818	270,268	906.1	-3,047	$34,285	-$3,467
AH	Solar PV	$ 1,559,823	$52,036	494,217	274.2	0	$52,036	$0
AH	Solar PV	$ 291,671	$7,956	69,372	53.4	0	$7,956	$0
AH	Lighting Controls	$ 33,210	$1,461	11,439	61.7	-75	$1,546	-$84
AH	AHU Replacement	(CP)	$2,188	8,660	0.0	1,139	$892	$1,295
AH	Internal/External LED Lighting	(CP)	$1,210	8,818	43.2	-20	$1,233	-$23
ESSC	Facility Scheduling	$ 25,747	$4,110	37,682	0.0	239	$3,781	$329
ESSC	Building Envelope	$ 2,112	$404	87	0.0	275	$9	$396
ESSC	AHU Replacement	(CP)	$962	5,126	43.6	59	$879	$83
ESSC	Internal/External LED Lighting	(CP)	$5,998	48,027	243.6	-443	$6,634	-$636
HH	Facility Scheduling	$ 45,796	$4,042	30,771	0.0	688	$3,088	$954
HH	Building Envelope	$ 2,274	$545	124	0.0	371	$12	$532
HH	Solar PV	$ 210,100	$4,104	38,056	34.0	0	$4,104	$0
HH	AHU Replacement	(CP)	$3,437	15,448	97.0	703	$2,441	$996
HH	Internal/External LED Lighting	(CP)	$808	6,250	34.8	-55	$886	-$79
HH	Electrical Gear Replacement	$ 207,420	$0	0	0.0	0	$0	$0
MH	Building Envelope	$ 13,219	$6,134	61,133	0.0	0	$6,134	$0
MH	Facility Scheduling	$ 8,697	$12,712	126,690	0.0	0	$12,712	$0
MH	Internal/External LED Lighting	$ 257,096	$20,021	133,233	892.8	0	$20,021	$0
MH	Solar PV	$ 581,609	$22,018	195,065	274.2	0	$22,018	$0
MH	Lighting Controls	$ 6,780	$325	3,239	0.0	0	$325	$0
PAC	Facility Scheduling	$ 8,697	$5,579	55,558	0.0	3	$5,575	$4
PAC	Building Envelope	$ 13,476	$1,094	10,907	0.0	0	$1,094	$0
PAC	Solar PV	$ 409,107	$13,142	119,668	133.9	0	$13,142	$0
PAC	Internal/External LED Lighting	(CP)	$14,899	101,703	674.4	0	$14,899	$0
PSA	Facility Scheduling	$ 31,110	$13,468	102,296	0.0	3,170	$9,033	$4,435
PSA	Building Envelope	$ 15,606	$1,970	1,589	0.0	1,275	$133	$1,836
PSA	Solar PV	$ 837,126	$41,266	317,047	1,203.8	0	$41,266	$0
PSA	Solar PV Remote Net Metering	$ 1,760,514	$54,626	530,861	0.0	0	$54,626	$0
PSA	AHU Replacement	(CP)	$1,405	7,685	56.9	95	$1,272	$133
PSA	Internal/External LED Lighting	(CP)	$7,084	61,356	313.2	-284	$7,493	-$409
BAS	Facility Scheduling	$ 17,529	$5,817	21,688	0.0	2,484	$2,344	$3,473
BAS	Building Envelope	$ 14,241	$983	410	0.0	655	$44	$939
BAS	AHU Replacement	(CP)	$870	3,634	29.9	121	$699	$171
BAS	Internal/External LED Lighting	(CP)	$5,001	37,238	184.8	-344	$5,494	-$493
CTC	Facility Scheduling	$ 7,656	$3,361	20,392	0.0	832	$2,204	$1,157
CTC	Building Envelope	$ 14,241	$535	117	0.0	364	$13	$522
CTC	AHU Replacement	(CP)	$1,003	5,023	39.4	54	$926	$77
CTC	Internal/External LED Lighting	(CP)	$2,629	19,564	97.2	-180	$2,887	-$258
HC	Facility Scheduling	$ 11,642	$1,009	5,662	0.0	291	$612	$397
HC	AHU Replacement	(CP)	$851	4,111	40.3	0	$851	$0
HC	Internal/External LED Lighting	(CP)	$2,397	17,533	92.4	-162	$2,630	-$233
INEW	Solar PV	$ 380,873	$8,200	69,320	78.1	0	$8,200	$0
PB	Facility Scheduling	$ 13,615	$1,470	9,668	0.0	311	$1,045	$425
PB	Building Envelope	$ 3,825	$448	168	0.0	300	$18	$430
PB	AHU Replacement	(CP)	$730	3,348	29.5	62	$642	$88
PB	Internal/External LED Lighting	(CP)	$4,264	30,673	168.0	-270	$4,651	-$387
ZH	Facility Scheduling	$ 3,553	$0	0	0.0	0	$0	$0
ZH	Internal/External LED Lighting	(CP)	$857	5,196	37.2	0	$857	$0
WAC	Building Envelope	$ 16,450	$2,863	1,749	0.0	2,365	$179	$2,684
WAC	Facility Scheduling	$ 59,601	$20,291	119,031	0.0	5,362	$14,206	$6,086
WAC	AHU Replacement	$ 868,300	$3,323	21,065	0.0	242	$3,048	$275
WAC	Internal/External LED Lighting	$ 155,512	$11,767	77,787	404.4	-744	$12,612	-$844
WAC	Solar PV	$ 1,765,123	$67,617	669,648	789.1	0	$67,617	$0
WAC	Lighting Controls	$ 8,865	$352	2,853	0.0	0	$352	$0
Total Project Savings		**$ 15,670,003**	**$600,741**	**4,658,865**	**7,542.3**	**62,074**	**$527,545**	**$73,196**
Total Baseline			**$1,330,860**	**8,856,797**	**22,111**	**185,512**	**$1,094,389**	**$236,471**
Post Project			**$730,119**	**$4,197,932**	**$14,569**	**$123,438**	**$566,844**	**$163,275**

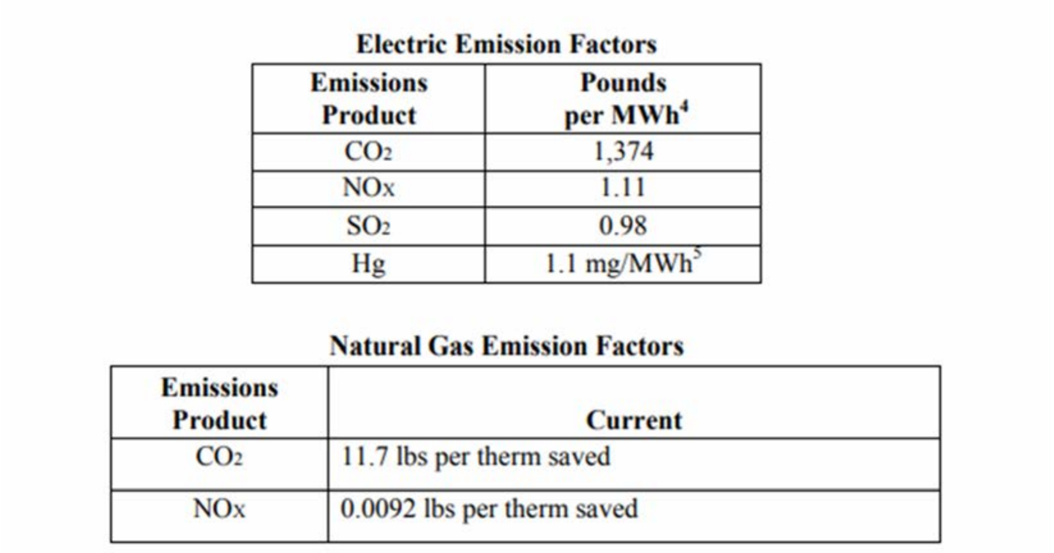
Notes: (CP) = customer project

4.4 Environmental Impact

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

Detail Unit Savings			Emissions Reduction					
			Electric Emissions				Natural Gas Emissions	
Electric (kWh)	Electric (kW)	Natural Gas (Therm)	Co2 (lb)	NOX (lb)	SO2 (lb)	Hg (mg)	Co2 (lb)	NOX (lb)
4,658,865	7,542	62,074	6,401	5,171	4,566	5,125	726,264	571

The above projections are based on NJ BPU guidelines shown below:



Electric Emission Factors

Emissions Product	Pounds per MWh[4]
CO_2	1,374
NOx	1.11
SO_2	0.98
Hg	1.1 mg/MWh[5]

Natural Gas Emission Factors

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

5.0 Performance Assurance Support Services (PASS)

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

5.1 Description of Services

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

Remote System Monitoring and Reporting

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

Remote Energy Management, Training & Technical Support

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

On-site Visits

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

- Expert advice to aid in energy planning based on operational and future commitments
- Identifying excess energy targets and recommendations for improvement
- An increase in overall energy awareness

Resource Advisor

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

Commission and Verify (C&V)

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

“Option B” Measurement and Verification

The International Performance Measurement & Verification Protocol (IPMVP) was created to determine standards and best practices in the measurement & verification of energy efficiency investments. The IPMVP Option B, retrofit isolation involves localized measurements to isolate the impact of specific energy conservation measures. Specifically, for Passaic’s ESP, this will ensure performance of the solar system is proven without having to be concerned about any other energy consuming interaction behind the utility meter.

5.2 Measurement & Verification (M&V) Plan

The purpose of the Performance Assurance Support Services (PASS) program is to assist the College in sustaining savings over the long term. Based upon the scope of this project, we recommend a measurement & verification (M&V) program as described below. Green-colored boxes indicate what is included in the recommended M&V program.

Location	**Measurement & Verificaton (M&V)**			
Site Name	Option B: Solar Production Guarantee	On-Site Visits & Training (# per year)	Resource Advisor	Solar Maintenance
Academic Hall	🟩	🟩 2x	🟩	🟩
Academic Addition	🟩	🟩 2x	🟩	🟩
Broadway Academic Center		🟩 1x	🟩	
Community Technology Center		🟩 1x	🟩	
Enrollment and Student Services Ctr	🟩	🟩 2x	🟩	🟩
Founders		🟩 1x	🟩	
Game Room	🟩	🟩 2x	🟩	🟩
Gym Theater		🟩 1x	🟩	
Hamilton Club		🟩 1x	🟩	
Hamilton Hall	🟩	🟩 2x	🟩	🟩
Memorial Hall	🟩	🟩 2x	🟩	🟩
Parking Deck		🟩 1x	🟩	
Passaic Academic Center	🟩	🟩 2x	🟩	🟩
Pruden Building		🟩 1x	🟩	
Pulbic Safety Academy	🟩	🟩 2x	🟩	🟩
Wanaque Academic Center	🟩	🟩 2x	🟩	🟩
Zendell Hall		🟩 1x	🟩	

The guarantee is based upon Option B methodology (as defined by IPMVP) for the energy efficiency measures at the sites above. Each year after the initial term, the services can be eliminated or negotiated between SE & PCCC, to ensure the proper level of support and savings verification.

Services Included:	Install and Year 1	Year 2
• Commissioning & Verify ECMs • Measurement & Verification of Savings • Financial guarantee/Quarterly Savings Reports • On-site Energy Auditing & Consulting/On-site Training • Resource Advisor/Building Automation System Reviews • Remote Energy Management & Technical Support	$120,127	$82,148

5.3 Ongoing Maintenance

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

ECM Category	O&M Impact
Lighting	Reduced O&M as lamps last much longer and ballasts are removed.
Envelope	Routine, no different than current maintenance of building.
HVAC	No additional maintenance would be required outside of routine maintenance that is being done on existing equipment.
Building Automation System	Software upgrades as necessary.
Chiller and Boiler	The College currently does not have a water treatment program on the chilled water loop or the hot water loop of Academic. It's recommended that after the new equipment is install that these loops be added to the existing condenser water treatment program. Current O&M procedures should continue on new equipment.
Solar	Solar maintenance is included in the measurement & verification plan above.

6.0 Implementation

6.1 Design & Compliance Issues

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

6.2 Assessment of Risks

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

- If actual operation of the buildings deviates significantly from the parameters outlined in the Energy Savings Plan with respect to temperature set points and occupied times, energy savings associated with the building automation system and HVAC upgrades could be affected. Please see standards of comfort appendix.
- Lighting systems will require maintenance as they age. Replacement parts need to be of similar energy efficiency to maintain savings.
- The existing operational chiller should undergo a detailed maintenance scope of work, including cleaning of the condenser and evaporator barrels to extend the life of this equipment.
- New HVAC and solar equipment will need to be maintained to manufacturers' specifications.
- The existing chilled water and heating hot water system will have a new chemical feeder that should be monitored through the existing condenser water agreement.

7.0 Appendices

7.1 Savings Calculations & Documentation

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

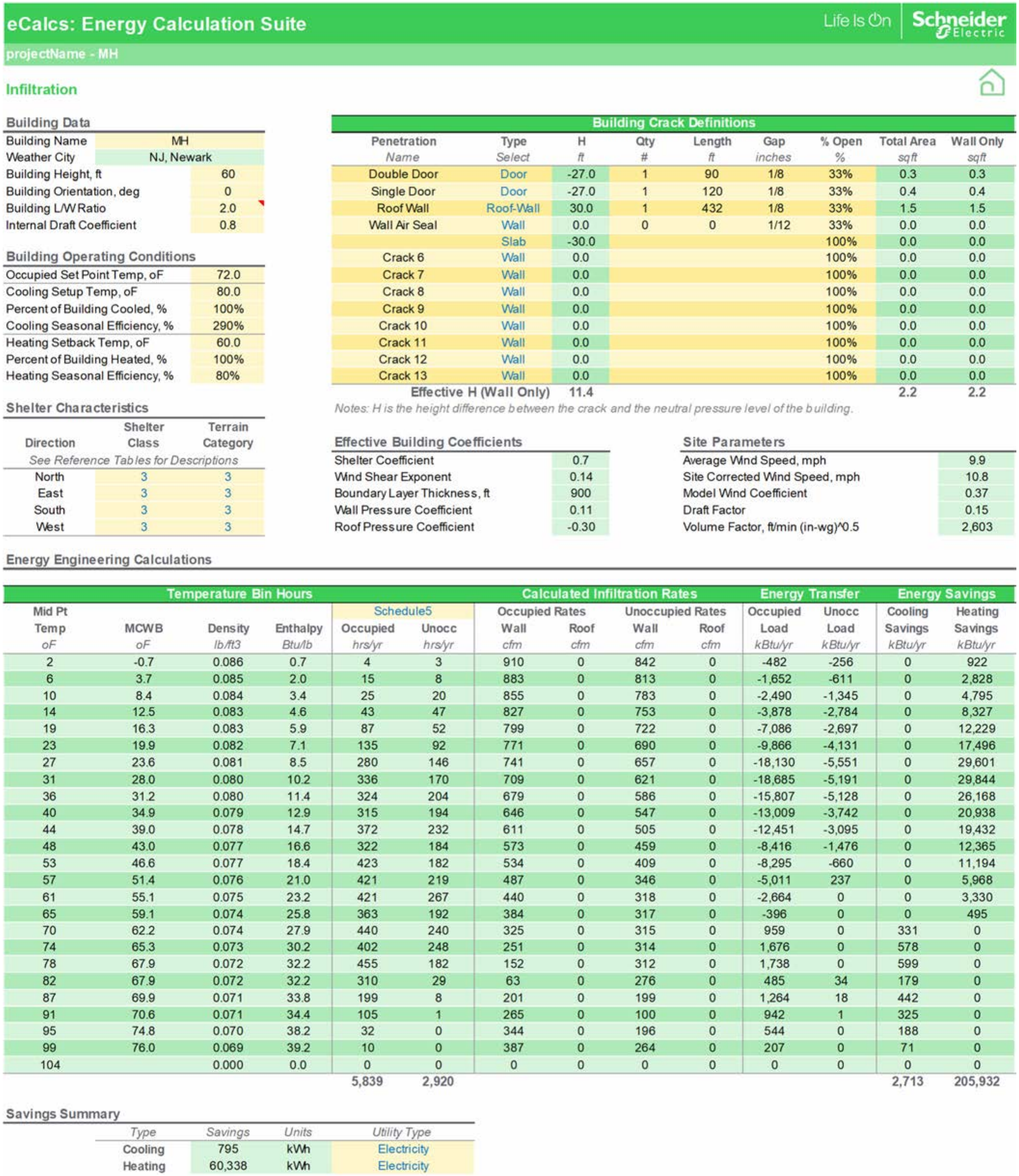
Energy Analysis Methodology

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

Savings Methods – Spreadsheet Calculations

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

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



eCalcs: Energy Calculation Suite

projectName - MH

Infiltration

Building Data

Building Name	MH
Weather City	NJ, Newark
Building Height, ft	60
Building Orientation, deg	0
Building L/W Ratio	2.0
Internal Draft Coefficient	0.8

Building Operating Conditions

Occupied Set Point Temp, oF	72.0
Cooling Setup Temp, oF	80.0
Percent of Building Cooled, %	100%
Cooling Seasonal Efficiency, %	290%
Heating Setback Temp, oF	60.0
Percent of Building Heated, %	100%
Heating Seasonal Efficiency, %	80%

Shelter Characteristics

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

Building Crack Definitions

Penetration	Type	H	Qty	Length	Gap	% Open	Total Area	Wall Only
Name	*Select*	*ft*	*#*	*ft*	*inches*	*%*	*sqft*	*sqft*
Double Door	Door	-27.0	1	90	1/8	33%	0.3	0.3
Single Door	Door	-27.0	1	120	1/8	33%	0.4	0.4
Roof Wall	Roof-Wall	30.0	1	432	1/8	33%	1.5	1.5
Wall Air Seal	Wall	0.0	0	0	1/12	33%	0.0	0.0
	Slab	-30.0				100%	0.0	0.0
Crack 6	Wall	0.0				100%	0.0	0.0
Crack 7	Wall	0.0				100%	0.0	0.0
Crack 8	Wall	0.0				100%	0.0	0.0
Crack 9	Wall	0.0				100%	0.0	0.0
Crack 10	Wall	0.0				100%	0.0	0.0
Crack 11	Wall	0.0				100%	0.0	0.0
Crack 12	Wall	0.0				100%	0.0	0.0
Crack 13	Wall	0.0				100%	0.0	0.0
Effective H (Wall Only)		**11.4**					2.2	2.2

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

Effective Building Coefficients

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

Site Parameters

Average Wind Speed, mph	9.9
Site Corrected Wind Speed, mph	10.8
Model Wind Coefficient	0.37
Draft Factor	0.15
Volume Factor, ft/min (in-wg)^0.5	2,603

Energy Engineering Calculations

Temperature Bin Hours						Calculated Infiltration Rates				Energy Transfer		Energy Savings	
Mid Pt				Schedule5		Occupied Rates		Unoccupied Rates		Occupied	Unocc	Cooling	Heating
Temp	MCWB	Density	Enthalpy	Occupied	Unocc	Wall	Roof	Wall	Roof	Load	Load	Savings	Savings
oF	*oF*	*lb/ft3*	*Btu/lb*	*hrs/yr*	*hrs/yr*	*cfm*	*cfm*	*cfm*	*cfm*	*kBtu/yr*	*kBtu/yr*	*kBtu/yr*	*kBtu/yr*
2	-0.7	0.086	0.7	4	3	910	0	842	0	-482	-256	0	922
6	3.7	0.085	2.0	15	8	883	0	813	0	-1,652	-611	0	2,828
10	8.4	0.084	3.4	25	20	855	0	783	0	-2,490	-1,345	0	4,795
14	12.5	0.083	4.6	43	47	827	0	753	0	-3,878	-2,784	0	8,327
19	16.3	0.083	5.9	87	52	799	0	722	0	-7,086	-2,697	0	12,229
23	19.9	0.082	7.1	135	92	771	0	690	0	-9,866	-4,131	0	17,496
27	23.6	0.081	8.5	280	146	741	0	657	0	-18,130	-5,551	0	29,601
31	28.0	0.080	10.2	336	170	709	0	621	0	-18,685	-5,191	0	29,844
36	31.2	0.080	11.4	324	204	679	0	586	0	-15,807	-5,128	0	26,168
40	34.9	0.079	12.9	315	194	646	0	547	0	-13,009	-3,742	0	20,938
44	39.0	0.078	14.7	372	232	611	0	505	0	-12,451	-3,095	0	19,432
48	43.0	0.077	16.6	322	184	573	0	459	0	-8,416	-1,476	0	12,365
53	46.6	0.077	18.4	423	182	534	0	409	0	-8,295	-660	0	11,194
57	51.4	0.076	21.0	421	219	487	0	346	0	-5,011	237	0	5,968
61	55.1	0.075	23.2	421	267	440	0	318	0	-2,664	0	0	3,330
65	59.1	0.074	25.8	363	192	384	0	317	0	-396	0	0	495
70	62.2	0.074	27.9	440	240	325	0	315	0	959	0	331	0
74	65.3	0.073	30.2	402	248	251	0	314	0	1,676	0	578	0
78	67.9	0.072	32.2	455	182	152	0	312	0	1,738	0	599	0
82	67.9	0.072	32.2	310	29	63	0	276	0	485	34	179	0
87	69.9	0.071	33.8	199	8	201	0	199	0	1,264	18	442	0
91	70.6	0.071	34.4	105	1	265	0	100	0	942	1	325	0
95	74.8	0.070	38.2	32	0	344	0	196	0	544	0	188	0
99	76.0	0.069	39.2	10	0	387	0	264	0	207	0	71	0
104		0.000	0.0	0	0	0	0	0	0	0	0	0	0
				5,839	2,920							2,713	205,932

Savings Summary

Type	Savings	Units	Utility Type
Cooling	795	kWh	Electricity
Heating	60,338	kWh	Electricity

Savings Methods – ELEMENT

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

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

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

Calculations

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

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

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

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

Weather and Solar Data

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

Sol-air Temperature, °F

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

Zone Loads

Sensible Zone Loads, Btu

- **Internal Heat Gains**
- Lighting, $Q_{S\_LTG} = L_{LTG} \times A_{BLDG} / 1000 \times HLP_{LTG} \times C$
- Equipment, $Q_{S\_EQUIP} = L_{EQUIP} \times A_{BLDG} / 1000 \times HLP_{EQUIP} \times C$
- People, $Q_{S\_PEOPLE} = n_{PEOPLE} \times HGF_{S\_PEOPLE} \times HLP_{PEOPLE}$
    - A_{BLDG} = building area, ft^2
    - C = conversion factor kW to kBtu = 3412 kBtu/kWh
    - HGF_{S_PEOPLE} = heat gain factor (sensible) based on activity level, (see Table 1), Btu/h-person
    - HLP = hourly load percentage of peak load based on assigned schedule, %
    - L = peak load density, W/ft^2
    - n_{PEOPLE} = number of people, persons
- **Envelope Loads**
- Wall, $Q_{S\_WALL} = 1/R_{WALL} \times (A_{WALL} - A_{WINDOW}) \times (T_{SA\_WALL} - T_{SP})$
- Roof, $Q_{S\_ROOF} = 1/R_{ROOF} \times (A_{ROOF}) \times (T_{SA\_ROOF} - T_{SP})$
- Window Conduction, $Q_{S\_WINDOW,C} = U_{WINDOW} \times A_{WINDOW} \times (T_{OA} - T_{SP})$
- Window Radiation, $Q_{S\_WINDOW,R} = A_{WINDOW} \times SHGC \times (1 - ES) \times I_N$
- Infiltration, $Q_{S\_INFIL} = \rho \times c_p \times q_{INF} \times A_{WALL} \times 60 \times (T_{OA} - T_{SP})$
    - ρ = density of outdoor air, lbm/ft^3
    - A_{ROOF} = roof area, ft^2
    - A_{WALL} = exterior wall area, ft^2
    - A_{WINDOW} = window area, ft^2
    - c_p = heat capacity of air = 0.24 Btu/lbm °F
    - ES = exterior shading, %
    - q_{INF} =infiltration rate per area of exterior wall, CFM/ft^2
    - R_{WALL} = R-value of roof, hr-ft^2-°F/Btu
    - R_{ROOF} = R-value of roof, hr-ft^2-°F/Btu
    - SHGC = solar heat gain coefficient based on window selection (see Table 2), dimensionless
    - T_{OA} = outdoor air dry bulb temperature, °F
    - T_{SA_ROOF} = sol-air temperature of the roof, °F
    - T_{SA_WALL} = sol-air temperature of the wall, °F
    - T_{SP} = indoor air dry bulb temperature, °F
    - U_{WINDOW} = U-value of the window based on window selection (see Table 3), Btu/h-°F-ft^2

Latent Zone Loads, Btu

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

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

Total Zone Loads, kBtu

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

System Loads

Ventilation, CFM

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

Ventilation Loads, Btu

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

Total System Loads, kBtu

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

Energy Consumption

Electric, kWh

- Lighting, $E_{LTG} = L_{LTG} \times A_{BLDG} / 1000 \times HLP_{LTG}$
- Equipment, $E_{EQUIP} = L_{EQUIP} \times A_{BLDG} / 1000 \times HLP_{EQUIP}$
- Miscellaneous Electric Load 1, $E_{MISCE,1} = L_{MISCE,1} \times HLP_{MISCE,1}$ (typical of 3)
    - $L_{MISCE,1}$ = peak miscellaneous electric load 1, kW (typical of 3)
    - $HLP_{MISCE,1}$ = hourly load percentage of miscellaneous electric load 1 (typical of 3)
- Fans, $E_{FAN} = E_{C,FAN} + E_{P,FAN} + E_{V,FAN}$

  If the HVAC schedule is on or if the fan availability is enabled and there is a load on the system, then
    - Constant fan speed, $E_{C,FAN} = L_{C,FAN}$
    - Proportional fan speed, $E_{P,FAN} = L_{V,FAN} \times PL$
    - Variable fan speed, $E_{V,FAN} = L_{V,FAN} \times PL^{2.5}$
        - $L_{C,FAN}$ = constant fan load, kW
        - $L_{V,FAN}$ = variable fan load, kW
        - S_{MIN_FAN} = minimum fan speed, %
        - PL = percentage of load equal to the maximum of $(Q_{S\_SYSTEM} / Q_{HTG\_DESIGN})$, $(Q_{TOTAL\_SYSTEM} / Q_{CLG\_DESIGN})$, or (S_{MIN_FAN})
- Pumps, $E_{PUMP} = E_{C,PUMP} + E_{P,PUMP} + E_{V,PUMP}$ (typical of heating and cooling)

  If the HVAC schedule is on or if the pump availability is enabled and there is a load on the system, then
    - Constant pump speed, $E_{C,PUMP} = L_{C,PUMP}$
    - Proportional pump speed, $E_{P,PUMP} = L_{V,PUMP} \times PL$
    - Variable pump speed, $E_{V,PUMP} = L_{V,PUMP} \times PL^{2.5}$

        - $L_{C,PUMP}$ = constant pump load, kW (typical of heating and cooling)
        - $L_{V,PUMP}$ = variable pump load, kW (typical of heating and cooling)
        - S_{MIN_PUMP} = minimum pump speed, % (typical of heating and cooling)
        - PL_{HTG} = percentage of heating load equal to the maximum of (Q_{S_SYSTEM} / Q_{HTG_DESIGN}) or $S_{MIN\_PUMP,HTG}$
        - PL_{CLG} = percentage of cooling load equal to the maximum of (Q_{TOTAL_SYSTEM} / Q_{CLG_DESIGN}) or $S_{MIN\_PUMP,CLG}$

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

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

Fuel, kBtu

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

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

- Envelope, $F_{HTG\_ENV} = (-1) \times Q_{S\_ZONE} \times (1 - P_{HTG,E}) \times (1 - P_{INF}) / \eta_{HTG\_PL,F}$
- Infiltration, $F_{HTG,INF} = (-1) \times Q_{S\_ZONE} \times (1 - PHTG,E) \times P_{INF} / \eta_{HTG\_PL,F}$
- Ventilation, $F_{HTG,VENT} = (-1) \times Q_{S\_VENT} \times (1 - P_{HTG,E}) / \eta_{HTG\_PL,F}$
    - Part Load Ratio, $PLR_{HTG} = Q_{S\_SYSTEM} / (Q_{HTG\_DESIGN} \times OF_{HTG})$, dimensionless
        - For miscellaneous fuel loads on the plant, Q_{S_SYSTEM} includes these loads.
    - Energy Input Ratio, $EIR_{HTG} = a + b \times PLR_{HTG} + c \times PLR_{HTG}^2$, dimensionless
    - Fuel Part Load Efficiency, $\eta_{HTG\_PL,F} = \eta_{HTG,F} \times PLR_{HTG} / EIR_{HTG}$, %
        - a, b, c = heating efficiency curve coefficients (see Table 5) based on system selection, dimensionless
        - $\eta_{HTG,F}$ = fuel nominal heating efficiency, %
        - OF_{HTG} = oversize factor used to adjust calculated heating design load, %
        - $P_{HTG,E}$ = percentage of load assigned to electric heat, %

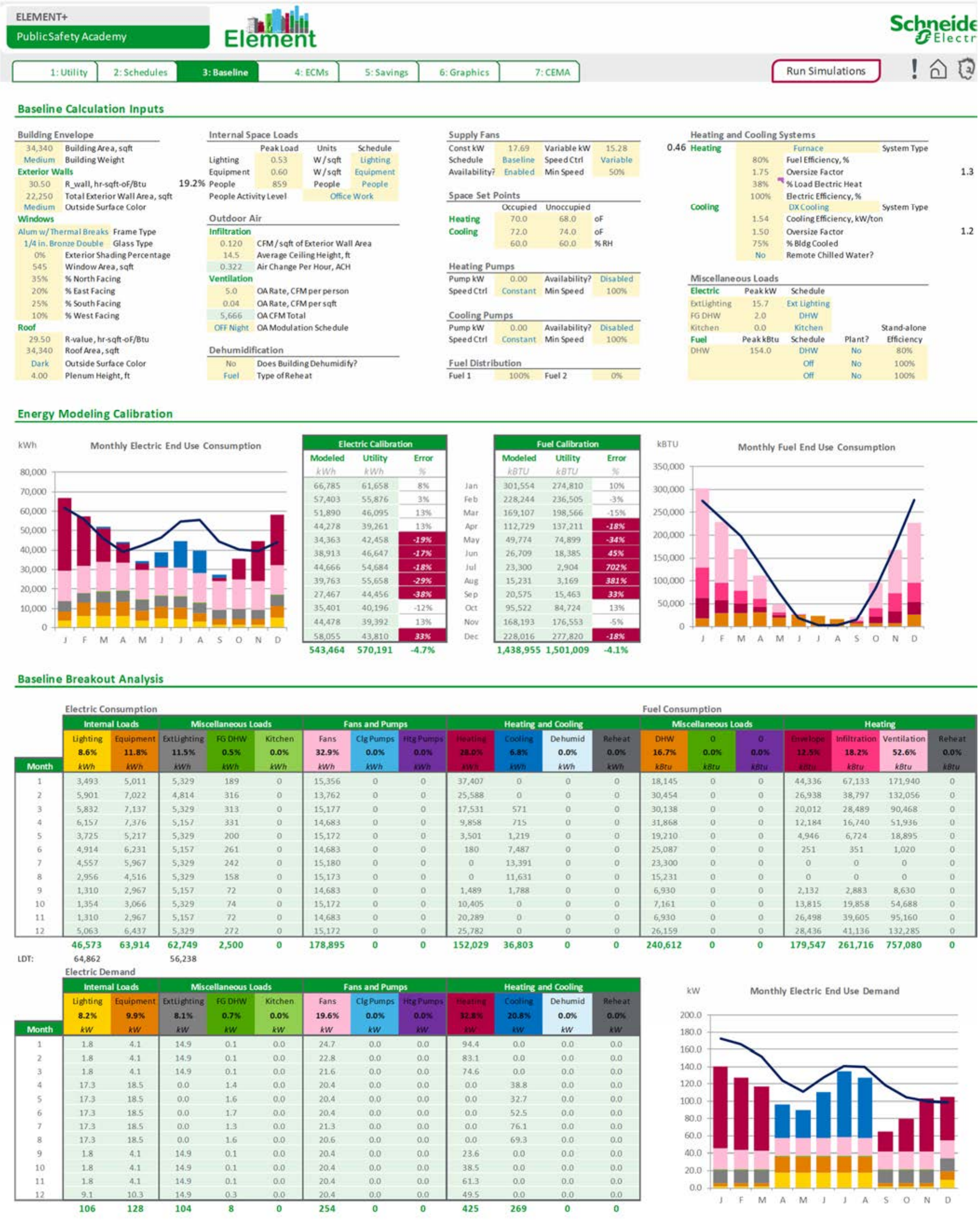
    - Q_{HTG_DESIGN} = heating design load calculated on design day conditions, kBtu
    - Q_{S_SYSTEM} = hourly calculated heating load (negative values), kBtu
  - Zone Envelope Sensible Load, $Q_{S\_ZONE,ENV} = Q_{S\_WALL} + Q_{S\_ROOF} + Q_{S\_WINDOW,C} + Q_{S\_WINDOW,R}$
  - Percent of Zone Sensible Load attributed to infiltration, $P_{INF} = Q_{S\_ZONE,INF} / (Q_{S\_ZONE,ENV} + Q_{S\_INF})$

Energy Demand

Electric, kW

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

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



Baseline Calculation Inputs

Building Envelope

34,340	Building Area, sqft
Medium	Building Weight
Exterior Walls	
30.50	R_wall, hr-sqft-oF/Btu
22,250	Total Exterior Wall Area, sqft
Medium	Outside Surface Color
Windows	
Alum w/ Thermal Breaks	Frame Type
1/4 in. Bronze Double	Glass Type
0%	Exterior Shading Percentage
545	Window Area, sqft
35%	% North Facing
20%	% East Facing
25%	% South Facing
10%	% West Facing
Roof	
29.50	R-value, hr-sqft-oF/Btu
34,340	Roof Area, sqft
Dark	Outside Surface Color
4.00	Plenum Height, ft

Internal Space Loads

		Peak Load	Units	Schedule
	Lighting	0.53	W / sqft	Lighting
	Equipment	0.60	W / sqft	Equipment
19.2%	People	859	People	People
	People Activity Level		Office Work	

Outdoor Air

Infiltration	
0.120	CFM / sqft of Exterior Wall Area
14.5	Average Ceiling Height, ft
0.322	Air Change Per Hour, ACH
Ventilation	
5.0	OA Rate, CFM per person
0.04	OA Rate, CFM per sqft
5,666	OA CFM Total
OFF Night	OA Modulation Schedule

Dehumidification

No	Does Building Dehumidify?
Fuel	Type of Reheat

Supply Fans

Const kW	17.69	Variable kW	15.28
Schedule	Baseline	Speed Ctrl	Variable
Availability?	Enabled	Min Speed	50%

Space Set Points

	Occupied	Unoccupied	
Heating	70.0	68.0	oF
Cooling	72.0	74.0	oF
	60.0	60.0	% RH

Heating Pumps

Pump kW	0.00	Availability?	Disabled
Speed Ctrl	Constant	Min Speed	100%

Cooling Pumps

Pump kW	0.00	Availability?	Disabled
Speed Ctrl	Constant	Min Speed	100%

Fuel Distribution

Fuel 1	100%	Fuel 2	0%

Heating and Cooling Systems

0.46	**Heating**	Furnace	System Type	
		80%	Fuel Efficiency, %	
		1.75	Oversize Factor	1.3
		38%	% Load Electric Heat	
		100%	Electric Efficiency, %	
	Cooling	DX Cooling	System Type	
		1.54	Cooling Efficiency, kW/ton	
		1.50	Oversize Factor	1.2
		75%	% Bldg Cooled	
		No	Remote Chilled Water?	

Miscellaneous Loads

Electric	Peak kW	Schedule		
ExtLighting	15.7	Ext Lighting		
FG DHW	2.0	DHW		
Kitchen	0.0	Kitchen		Stand-alone
Fuel	Peak kBtu	Schedule	Plant?	Efficiency
DHW	154.0	DHW	No	80%
		Off	No	100%
		Off	No	100%

Energy Modeling Calibration

Electric Calibration				Fuel Calibration		
Modeled	Utility	Error		Modeled	Utility	Error
kWh	kWh	%		kBTU	kBTU	%
66,785	61,658	8%	Jan	301,554	274,810	10%
57,403	55,876	3%	Feb	228,244	236,505	-3%
51,890	46,095	13%	Mar	169,107	198,566	-15%
44,278	39,261	13%	Apr	112,729	137,211	-18%
34,363	42,458	-19%	May	49,774	74,899	-34%
38,913	46,647	-17%	Jun	26,709	18,385	45%
44,666	54,684	-18%	Jul	23,300	2,904	702%
39,763	55,658	-29%	Aug	15,231	3,169	381%
27,467	44,456	-38%	Sep	20,575	15,463	33%
35,401	40,196	-12%	Oct	95,522	84,724	13%
44,478	39,392	13%	Nov	168,193	176,553	-5%
58,055	43,810	33%	Dec	228,016	277,820	-18%
543,464	570,191	-4.7%		1,438,955	1,501,009	-4.1%

Baseline Breakout Analysis

Electric Consumption

	Internal Loads		Miscellaneous Loads			Fans and Pumps			Heating and Cooling			
	Lighting	Equipment	ExtLighting	FG DHW	Kitchen	Fans	Clg Pumps	Htg Pumps	Heating	Cooling	Dehumid	Reheat
	8.6%	11.8%	11.5%	0.5%	0.0%	32.9%	0.0%	0.0%	28.0%	6.8%	0.0%	0.0%
Month	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh
1	3,493	5,011	5,329	189	0	15,356	0	0	37,407	0	0	0
2	5,901	7,022	4,814	316	0	13,762	0	0	25,588	0	0	0
3	5,832	7,137	5,329	313	0	15,177	0	0	17,531	571	0	0
4	6,157	7,376	5,157	331	0	14,683	0	0	9,858	715	0	0
5	3,725	5,217	5,329	200	0	15,172	0	0	3,501	1,219	0	0
6	4,914	6,231	5,157	261	0	14,683	0	0	180	7,487	0	0
7	4,557	5,967	5,329	242	0	15,180	0	0	0	13,391	0	0
8	2,956	4,516	5,329	158	0	15,173	0	0	0	11,631	0	0
9	1,310	2,967	5,157	72	0	14,683	0	0	1,489	1,788	0	0
10	1,354	3,066	5,329	74	0	15,172	0	0	10,405	0	0	0
11	1,310	2,967	5,157	72	0	14,683	0	0	20,289	0	0	0
12	5,063	6,437	5,329	272	0	15,172	0	0	25,782	0	0	0
	46,573	63,914	62,749	2,500	0	178,895	0	0	152,029	36,803	0	0
LDT:	64,862		56,238									

Fuel Consumption

	Miscellaneous Loads			Heating			
	DHW	0	0	Envelope	Infiltration	Ventilation	Reheat
	16.7%	0.0%	0.0%	12.5%	18.2%	52.6%	0.0%
Month	kBtu	kBtu	kBtu	kBtu	kBtu	kBtu	kBtu
1	18,145	0	0	44,336	67,133	171,940	0
2	30,454	0	0	26,938	38,797	132,056	0
3	30,138	0	0	20,012	28,489	90,468	0
4	31,868	0	0	12,184	16,740	51,936	0
5	19,210	0	0	4,946	6,724	18,895	0
6	25,087	0	0	251	351	1,020	0
7	23,300	0	0	0	0	0	0
8	15,231	0	0	0	0	0	0
9	6,930	0	0	2,132	2,883	8,630	0
10	7,161	0	0	13,815	19,858	54,688	0
11	6,930	0	0	26,498	39,605	95,160	0
12	26,159	0	0	28,436	41,136	132,285	0
	240,612	0	0	179,547	261,716	757,080	0

Electric Demand

	Internal Loads		Miscellaneous Loads			Fans and Pumps			Heating and Cooling			
	Lighting	Equipment	ExtLighting	FG DHW	Kitchen	Fans	Clg Pumps	Htg Pumps	Heating	Cooling	Dehumid	Reheat
	8.2%	9.9%	8.1%	0.7%	0.0%	19.6%	0.0%	0.0%	32.8%	20.8%	0.0%	0.0%
Month	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW
1	1.8	4.1	14.9	0.1	0.0	24.7	0.0	0.0	94.4	0.0	0.0	0.0
2	1.8	4.1	14.9	0.1	0.0	22.8	0.0	0.0	83.1	0.0	0.0	0.0
3	1.8	4.1	14.9	0.1	0.0	21.6	0.0	0.0	74.6	0.0	0.0	0.0
4	17.3	18.5	0.0	1.4	0.0	20.4	0.0	0.0	0.0	38.8	0.0	0.0
5	17.3	18.5	0.0	1.6	0.0	20.4	0.0	0.0	0.0	32.7	0.0	0.0
6	17.3	18.5	0.0	1.7	0.0	20.4	0.0	0.0	0.0	52.5	0.0	0.0
7	17.3	18.5	0.0	1.3	0.0	21.3	0.0	0.0	0.0	76.1	0.0	0.0
8	17.3	18.5	0.0	1.6	0.0	20.6	0.0	0.0	0.0	69.3	0.0	0.0
9	1.8	4.1	14.9	0.1	0.0	20.4	0.0	0.0	23.6	0.0	0.0	0.0
10	1.8	4.1	14.9	0.1	0.0	20.4	0.0	0.0	38.5	0.0	0.0	0.0
11	1.8	4.1	14.9	0.1	0.0	20.4	0.0	0.0	61.3	0.0	0.0	0.0
12	9.1	10.3	14.9	0.3	0.0	20.4	0.0	0.0	49.5	0.0	0.0	0.0
	106	128	104	8	0	254	0	0	425	269	0	0

Modeling the ECMs

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

For detailed savings calculations for each ECM, please see the Appendix 7.1 Box Folder.

7.2 Preliminary Mechanical Designs

Please see the Appendices Box folder for preliminary mechanical designs.

7.3 Local Government Energy Audit (LGEA)

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

7.4 Solar Layouts

The solar layouts for each system are provided here.

7.5 Window Design

The 60% design set is provided for reference.

7.6 Standards of Comfort

Provided in this appendix is the standards of comfort documentation. This outlines what the expected operation of the facilities post project.

7.7 Third Party Review & Approval Report

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

7.8 Board of Public Utilities (BPU) Approval

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