Spencer-East Brookfield RSD

Annual Performance Assurance Report

Annual Period 1: 3/1/2021 – 2/28/2022

Submitted: August 2022

Energy Management Service Agreement
Performance Assurance Overview

Client:	**Spencer-East Brookfield Regional School District** 306 Main Street Spencer, MA 01562
Client Contact:	**Gary D. Suter, Comptroller** Phone: (508) 885-8500 Email: suterg@sebrsd.org
Contract Date:	**May 29th, 2019**
Construction Period:	**May 29th, 2019– February 28th, 2021**
Performance Guarantee Period:	**March 1st, 2021– February 28th, 2032**
Performance Guarantee Term:	**10 Years**
Current Annual Period:	**March 1st, 2021– February 28th, 2022**
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TABLE OF CONTENTS

INDEX OF TABLES AND FIGURES

1. Executive Summary

Siemens Industry, Inc. (Siemens) is pleased to provide Spencer-East Brookfield RSD (SEBRSD) with this Annual Period 1 Performance Assurance Report. This report details the energy performance of the project implemented by comparing Annual Realized Savings to the Guaranteed Annual Savings for the current Annual Period. The Energy Management Services Agreement (Contract) guaranteed **$184,743** in Savings for Annual Period 1. Annual Realized Savings for Annual Period 1 amounted to **$203,146**, which included **$197,146** in Measured & Verified Savings, **$6,000** in Operational Savings. The total Annual Realized Savings for Annual Period 1 exceeded the Guaranteed Annual Savings by **$184,743**, or 10%. (Table 1). Construction Savings total $264,718 and these savings are detailed in section 5 of this report.

Table 1: Cost Savings by Annual Period

Performance Period	Measured & Verified Energy Savings	Total Realized Energy Savings	Operational Savings	Annual Realized Savings	Guaranteed Annual Savings	Savings Excess / Shortfall
Construction	$264,718	$264,718	$0	$264,718	$0	$264,718
1	$197,146	$197,146	$6,000	$203,146	$184,743	$18,403
Total	**$461,864**	**$461,864**	**$6,000**	**$467,864**	**$184,743**	**$283,121**

Annual Realized Savings in energy units achieved in Annual Period 1 include reductions in electric energy, natural gas, and #2 fuel oil consumption (Table 2).

Table 2: Energy Savings for Annual Period 1

Savings Type	Electric Energy Savings (kWh/yr)	Natural Gas Savings (UNITS/yr)	#2 Fuel Oil Savings (Gal/yr)
Total Realized Savings	1,738,449	(214,968)	231,307
Realized Construction Period	*902,804*	*(158,701)*	*163,469*
Realized Annual Period 1	835,645	(56,267)	67,838
Total Guaranteed Savings	*760,279*	*(62,633)*	*67,838*
Savings Variance	978,170	(152,335)	163,469

A list of the Facility Improvement Measures (FIMs) implemented as part of this project is presented below:

- Lighting Retrofit & Occupancy Sensors
- Building Envelope Improvements
- Boiler Replacements
- Walk-in Cooler Controls Installation
- EMS Upgrade: Demand Control Ventilation
- EMS Upgrade: Temperature Setback
- Plug Load Controllers
- Premium Efficiency Motors and VFDs

2. Greenhouse Gas Emissions Reduction

Spencer-East Brookfield RSD's reduction of energy consumption also benefitted the environment by decreasing the amount of carbon dioxide (CO_2) and greenhouse gas emissions released into the atmosphere. Spencer-East Brookfield RSD reduced its annual emissions by **675 metric tons of CO_2e** during the current Annual Period. This calculation estimates the project's carbon footprint reduction based on realized electric energy, fuel oil and natural gas savings.

As shown in **Figure 1**, Siemens has converted the savings information into relevant comparisons, including the emissions created from the average American home over 78 years, the number of cars taken off the road each year (146), the number of tree seedlings grown for 10 years (11,244), or the number of barrels of oil consumed per year (1,569). These results can be used to communicate the reduction accomplishments, develop a greenhouse gas reduction strategy, or support a range of initiatives to reduce the overall environmental impact.

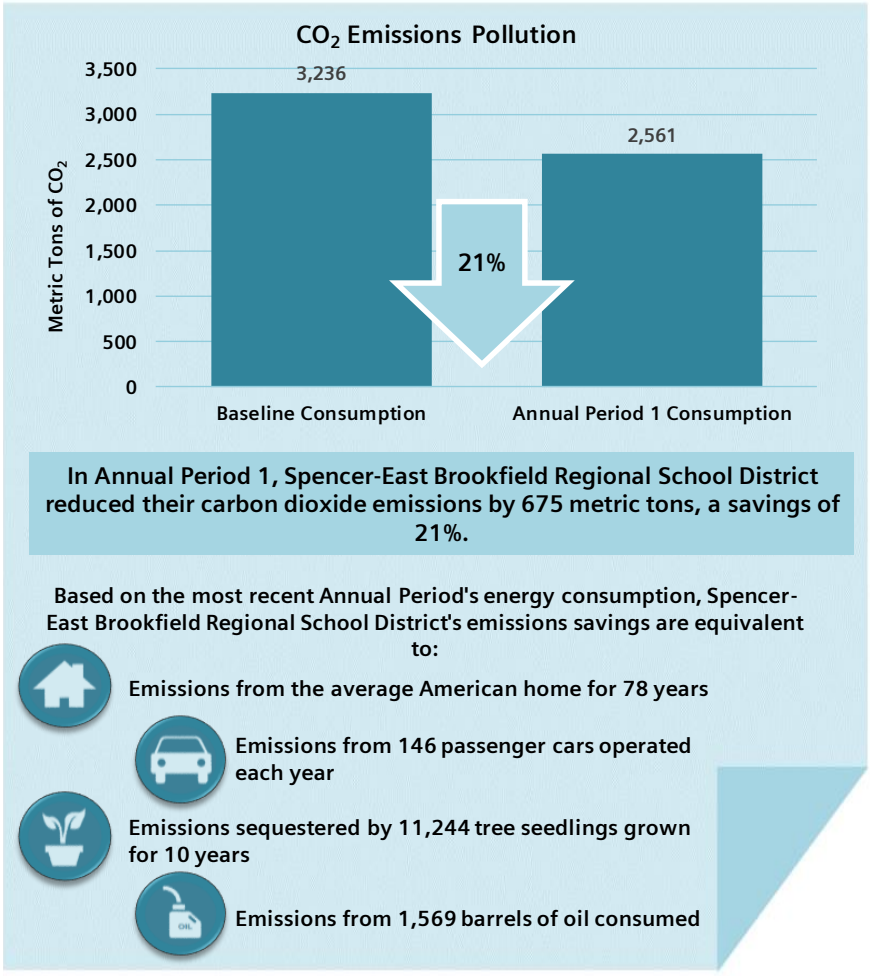

Figure 1: Greenhouse Gas Emissions Reduction for Annual Period 1

3. Performance Assurance Overview

3.1. Measurement & Verification Methods

There are five measurement and verification ("M&V") options to measure and verify energy/utility Savings, as described in Article 2 of Contract Attachment F– Performance Assurance. Options A through and including D are part of International Performance Measurement and Verification Protocol (IPMVP). Option E is based on industry accepted engineering standards. The individual options are described in further detail below. Note that per the Contract, Options A and B were used in the calculation of Savings for this project.

Option A - Measured Capacity. This approach is intended for Facility Improvement Measures where a one-time measurement for specific equipment or systems instantaneous baseline energy use, and a one-time measurement for specific equipment or systems instantaneous post-implementation (Post) energy use can be measured. Baseline and Post energy consumption is calculated by multiplying the measured end use instantaneous capacity (i.e. – kW, Gal/hr, BTU/hr) by stipulated hours of operation for each mode of operation (i.e. – hours, week, month). The calculations for energy consumption will be defined in the Measurement and Verification article of Attachment F of the contract

Option B - Measured Consumption. This approach is intended for Facility Improvement Measures where continuous periodic measurements for specific equipment or systems baseline energy use, and continuous periodic measurements for that equipment or systems post-implementation (Post) energy use can be measured. The calculations for energy consumption will be defined in the Measurement and Verification article of Attachment F of the contract. Periodic inspections and consumption measurements of the equipment or systems will be necessary to verify the on-going efficient operation of the equipment and saving attainment.

Option C - Main Meter Comparison. This approach is intended for measurements of the whole-facility or specific meter baseline energy use, and measurements of whole-facility or specific meter post-implementation (Post) energy use can be measured. The methodology to establish baseline and Post parameter identification, modeling approach and baseline or model adjustments will be defined in the Measurement and Verification article of Attachment F of the contract. Periodic inspections of baseline energy usage, operating practices, and facility and equipment, and meter measurements of the will be necessary to verify the on-going efficient operation of the equipment, systems, practices and facility, and saving attainment.

Option D - Stipulated. This approach is intended for an ECM where 1) the end use capacity or operational efficiency, 2) the demand, energy consumption or power level, or, 3) the manufacturer's measurements, industry standard efficiencies or operating hours, are known in advance, and used in an analysis that allows a mathematical calculation of the outcome. Both CUSTOMER and SIEMENS agree to the stipulated inputs and outcome(s) of the analysis methodology. Based on the established analytical methodology the Stipulated Savings will be achieved upon Substantial Completion of the ECM and no further measurements or calculations will need to be performed. The methodology and calculations to establish the Savings value is defined in the Measurement and Verification article of Attachment F of the contract.

3.2. Guaranteed Savings

The following section reiterates the contract Guaranteed Annual Savings for the FIMs installed at Spencer-East Brookfield RSD, as found in Articles 1 and 2 of Contract Attachment F – Performance Assurance. Guaranteed energy savings remain constant throughout the Performance Guarantee Period (Table 3 & 4).

Table 3: Guaranteed Savings (Units)

Performance Period	Electric Energy Savings (kWh/yr)	Natural Gas Savings (UNITS/yr)	#2 Fuel Oil Savings (Gal/yr)
Annual Period 1 – 10	760,279	(62,633)	67,838

Table 4 - Guaranteed Energy Savings by Location

Location	Electric Energy Savings (kWh)	Natural Gas Savings (Therms)	#2 Fuel Oil Savings (Gal)
David Prouty High School	95,819	(38,037)	35,652
Knox Trail Middle School	295,531	(32,209)	32,186
Wire Village Elementary School	214,438	4,246	0
East Brookfield Elementary School	132,223	3,366	0
School Administration Building	22,268	0	0
Total	**760,279**	**(62,633)**	**67,838**

The Guaranteed Cost Savings for each Annual Period (Table 5) are extrapolated from the Guaranteed Energy Savings by multiplying the energy unit Savings by the Baseline utility rates including the stipulated Escalation Rates.

Table 5: Guaranteed Savings (Cost)

Performance Period	Energy/Utility Savings	Operational Savings	Total Savings
Construction	$0	$0	$0
1	$178,743	$6,000	$184,743
2	$184,105	$6,180	$190,285
3	$189,628	$6,365	$195,994
4	$195,317	$6,556	$201,873
5	$201,177	$6,753	$207,930
6	$207,212	$6,956	$214,167
7	$213,428	$7,164	$220,592
8	$219,831	$7,379	$227,210

Performance Period	Energy/Utility Savings	Operational Savings	Total Savings
9	$226,426	$7,601	$234,027
10	$233,219	$7,829	$241,047
Total	**$2,049,086**	**$68,783**	**$2,117,869**

The Performance Guarantee does not operate to guarantee savings per-FIM. Rather, the calculation of savings is based on aggregate performance of all the FIMs contained in the project (Table 6). The operational savings associated with the lighting improvement measure are higher than in the contract because of an error that resulted in part of the operational savings for East Brookfield Elementary being counted in the energy savings.

Table 6: Guaranteed Cost Savings by FIM & Option Type for Annual Period 1

Facility Improvement Measure	Option A Savings ($)	Option B Savings ($)	Total Energy Savings	Operational Savings ($)	Total Savings ($)
Lighting Retrofit and Lighting Controls	$111,581	$0	$111,581	$7,500	$119,081
Plug Load Controls	$2,002	$0	$2,002	$0	$2,002
Building Envelope Improvements	$8,772	$0	$8,772	$0	$8,772
EMS Upgrade	$10,352	$0	$10,352	$0	$10,352
Kitchen Hood Controls	$5,314	$0	$5,314	$0	$5,314
Walk-in Cooler Controls	$5,663	$0	$5,663	$0	$5,663
Boiler Replacement	$28,946	$0	$28,946	$0	$28,946
Boiler Upgrade-Premium Efficiency Motors and VFDs	$0	$4,613	$4,613	$0	$4,613
Total	**$172,629**	**$4,613**	**$177,243**	**$7,500**	**$184,743**

Spencer-East Brookfield RSD and Siemens affirmed that the Operational Savings are Stipulated Savings for the purposes of calculating Annual Realized Savings. Operational Savings are not measured or monitored during the Performance Guarantee Period (Table 7). The contractual Escalation Factor applied to Operational Savings is 3% annually. Operational savings at East Brookfield Elementary School is higher than in contract due to the error in savings calculations resulting in the operational savings being considered in the energy savings guarantee, as well as the operational savings. This additional operational savings is considered to be applied twice in the guaranteed savings, so only the original $1,500 of operational savings are considered achieved.

Table 7: Source of Operational Savings

Description	First Annual Period Savings	Operational Savings Persistence (Years)	Annual Period Savings Begin
East Brookfield Elementary	$3,000	10	1
David Prouty High School	$1,500	10	1
Knox Trail Middle School	$1,500	10	1
Wire Village Elementary School	$1,400	10	1
School Administration building	$100	10	1

3.3. Baseline Data

The Baseline Period is the period of time for which data was provided to Siemens to derive baseline measurements. **Table 8** outlines the average annual utility consumption during the Baseline Period, as found in Article 5 of Contract Attachment F – Performance Assurance.

Table 8: Baseline Energy Consumption by Location

Location	Electric Energy Consumption (kWh)	Natural Gas Consumption (UNITS)	#2 Fuel Oil Consumption (Gal)
East Brookfield Elementary School	367,840	16,797	N/A
Wire Village Elementary School	671,600	24,184	N/A
Knox Trail Middle School	523,680	591	32,242
David Prouty High School	494,400	1,822	35,652
Administration Building	31,883	N/A	N/A
Total	**2,089,403**	**43,394**	**67,894**

The operating practices during the Baseline Period determined the utility consumption. **Table 9** shows the baseline (pre-retrofit) operating parameters for each facility that were in effect during the Baseline Period.

Table 9: Baseline Operating Temperatures

Location	Occupied Space Temperature	Unoccupied Space Temperature
East Brookfield Elementary School	72	72
Wire Village Elementary School	72	72
Knox Trail Middle School	72	72
David Prouty High School	70	70
Administration Building	72	72

Table 10: Baseline Operating Hours

Location	Occupied Heating Hrs/Wk	Unoccupied Heating Hrs/Wk
East Brookfield Elementary School	47.5 Monday – Friday, 8:00 AM to 4:00 PM Morning program starts at 6:30 AM	168.5 Monday – Friday, 4:00 PM to 6:30 AM Saturday and Sunday, 24 hours each
Wire Village Elementary School	47.5 Monday – Friday, 8:00 AM to 4:00 PM After school program starts at 5:30 AM	168.5 Monday – Friday, 5:30 PM to 8:00 AM Saturday and Sunday, 24 hours each
Knox Trail Middle School	40.0 Monday – Friday, 8:00 AM to 4:00 PM	128.0 Monday-Friday, 4:00 PM to 8:00 AM Saturday and Sunday, 24 Hours each
David Prouty High School	40.0 Monday – Friday, 8:00 AM to 4:00 PM	128.0 Monday-Friday, 4:00 PM to 8:00 AM Saturday and Sunday, 24 Hours each
Administration Building	45.0 Monday – Friday, 7:30 AM to 4:30 PM	128.0 Monday-Friday, 4:30 PM to 7:30 AM Saturday and Sunday, 24 Hours each

3.4. Contracted Baseline (Post-Retrofit) Data

The Contracted Baseline is the post-retrofit facility operating profile based on parameters described in Article 7 of Contract Attachment F – Performance Assurance, which SEBRSD is responsible for maintaining throughout the Performance Guarantee Period. These parameters are relied upon by Siemens for the calculation of Guaranteed Annual Savings. **Table 11** shows the contracted post-retrofit (post-retrofit) operating parameters that were implemented under the Contract. As established in Article 3 of Contract Attachment F – Performance Assurance, SEBRSD must provide Siemens with accurate facility operating information within thirty days of any Material Change that may increase or decrease energy usage.

Table 11: Contracted Baseline (Post-Retrofit) Operating Temperatures

Location	Occupied Space Temperature	Unoccupied Space Temperature
East Brookfield Elementary School	72	68
Wire Village Elementary School	72	68
Knox Trail Middle School	72	68
David Prouty High School	70	68
Administration Building	72	70

Table 12: Contracted Baseline (Post-Retrofit) Operating Hours/Schedule

Location	Occupied Heating Hrs/Wk	Unoccupied Heating Hrs/Wk
East Brookfield Elementary School	47.5 Monday - Friday, 8:00 AM to 4:00 PM Morning Program starts at 6:30 AM	168.5 Monday - Friday, 4:00 PM to 6:30 AM Saturday and Sunday, 24 hours each
Wire Village Elementary School	47.5 Monday - Friday, 8:00 AM to 4:00 PM After school program starts at 5:30 PM	168.5 Monday - Friday, 5:30 PM to 8:00 AM Saturday and Sunday, 24 hours each
Knox Trail Middle School	40.0 Monday - Friday, 8:00 AM to 4:00 PM	128.0 Monday - Friday, 4:00 PM to 8:00 AM Saturday and Sunday, 24 hours each
David Prouty High School	40.0 Monday - Friday, 8:00 AM to 4:00 PM	128.0 Monday - Friday, 4:00 PM to 8:00 AM Saturday and Sunday, 24 hours each
Administration Building	45.0 Monday - Friday, 8:00 AM to 4:30 PM	123.0 Monday - Friday, 4:30 PM to 7:30 AM Saturday and Sunday, 24 hours each

3.5. Utility Rate Structures & Escalation Rates

SEBRSD and Siemens agreed that the energy cost savings for each Annual Period are calculated by multiplying the realized energy savings in units by the Annual Period's stipulated contract utility rate and applying the appropriate Escalation Rates, not the Annual Period's actual utility rate. The Annual Period 1 contract utility rates are established in Article 6 of Contract Attachment F – Performance Assurance. An Escalation Rate of 3% is applied to the contract utility rates annually beginning in Annual Period 2. The current Annual Period's contract utility rates are provided in Table 13.

Table 13: Contract Utility Rates for Annual Period 1

Location	Electric Energy ($/kWh)	Natural Gas ($/Therms)	#2 Fuel Oil ($/Gal)
David Prouty High School	$0.1712	$1.26	$1.82
Knox Trail Middle School	$0.1663	$1.01	$1.77
Wire Village Elementary School	$0.1633	$1.00	$0.00
East Brookfield Elementary School	$0.1759	$1.06	$0.00
School Administration Building	$0.1843	$0.00	$0.00

4. Performance Assurance Results

4.1. Summary of Realized & Guaranteed Savings

Annual Realized Savings for Annual Period 1 amounted to **$203,146**, comprised of **$192,431** in Option A, **$4,715** in Option B, and **$6,000** in Operational Savings. These cost and energy savings are summarized by location in Figure 2 and by FIM and Option Type in Table 14. Annual Realized Savings exceeded the Guaranteed Annual Savings of **$184,743** by **$18,403**, or 10%. The following sections detail the Savings associated with each FIM under their respective option types.

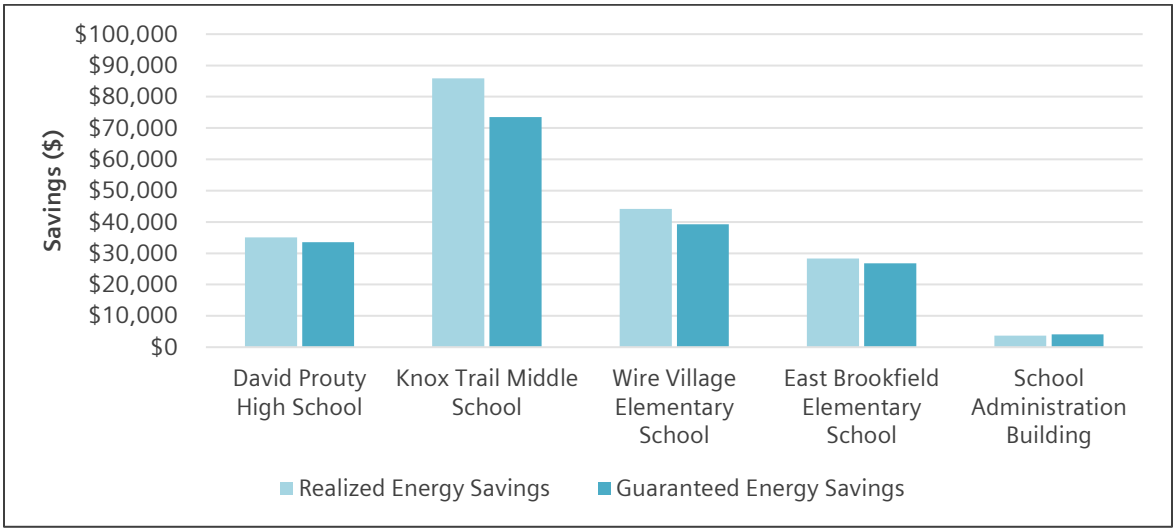

Figure 2: Cost Savings by Location for Annual Period 1 (excludes Operational Savings)

Table 14: Savings Variance by FIM for Annual Period 1

Facility Improvement Measure	Realized Option A Savings	Realized Option B Savings	Operational Savings	Total Realized Savings	Total Guaranteed Savings	Savings Variance
Lighting Retrofit and Lighting Controls	$125,635	$0	$6,000	$131,635	$119,081	$12,555
Plug Load Controls	$2,870	$0	$0	$2,870	$2,002	$867
Building Envelope Improvements	$12,282	$0	$0	$12,282	$8,772	$3,510
EMS Upgrade	$9,753	$0	$0	$9,753	$10,352	($599)
Kitchen Hood Controls	$0	$0	$0	$0	$5,314	($5,314)
Walk-in Cooler Controls	$6,258	$0	$0	$6,258	$5,663	$595
Boiler Replacement	$35,632	$0	$0	$35,632	$28,946	$6,687
Boiler Upgrade-Premium Efficency Motors and VFDs	$0	$4,715	$0	$4,715	$4,613	$102
Total	**$192,431**	**$4,715**	**$6,000**	**$203,146**	**$184,743**	**$18,403**

4.2. Option A Energy Savings

Realized Option A Savings for the current Annual Period amounted to **$192,431**, which exceeded the guaranteed **$172,629** in Savings by **$19,802**, or 11%. Option A FIMs include Lighting Improvements, Plug Load Controls, Building Envelope, EMS Upgrades, Kitchen Hood, Walk-in Cooler Controls, and Boiler Replacement (Table 15).

Table 15: Option A Savings for Annual Period 1

Facility Improvement Measure	Electric Energy Savings (kWh)	Natural Gas Savings (Therms)	#2 Fuel Oil Savings (Gal)	Realized Savings	Guaranteed Savings	Savings Variance
Lighting Retrofit and Lighting Controls	748,263	0	0	$125,635	$111,581	$14,054
Plug Load Controls	16,901	0	0	$2,870	$2,002	$868
Building Envelope Improvements	9,715	9,717	0	$12,282	$8,772	$3,510
EMS Upgrade	0	9,673	0	$9,753	$10,352	($599)
Kitchen Hood Controls	0	0	0	$0	$5,314	($5,314)
Walk-in Cooler Controls	36,879	0	0	$6,258	$5,663	$595
Boiler Replacement	0	(75,658)	67,838	$35,632	$28,946	$6,686
Total	**811,758**	**(56,267)**	**67,838**	**$192,431**	**$172,629**	**$19,802**

4.2.1. Lighting Retrofit and Controls

Siemens retrofitted existing lighting fixtures throughout the district. Electric energy savings (kWh) result from replacing existing lamps and ballasts with higher efficiency replacements. In total, Siemens installed 4,640 fixtures, including 1,181 fixtures at David Prouty HS, 1,111 at Knox Trail MS, 1,385 at Wire Village ES, 899 fixtures at East Brookfield ES and 64 fixtures at the administration building.

Energy Savings resulting from the lighting retrofit were verified based upon one-time pre-retrofit and one-time post-retrofit measurement of the lighting power capacity upon completion of the lighting retrofit project and trended operating hours for fixtures with lighting controls installations at David Prouty, East Brookfield and Wire Village. Fixtures not connected to lighting controls were estimated to have operating hours in line with the contract. A representative sample of each lighting fixture type was used to determine the post-retrofit electric power (kW). As shown in Table 16 and Table 17, the pre-retrofit and post-retrofit power mostly measured less than the expected. The lower-than-expected post-retrofit power measurements led to an excess in savings.

Table 16: Pre-retrofit Lighting Measurements

Facility	Retrofit Period	Fixture Type	Population Size	Sample Quantity	Wattage (W)		
					Expected	Measured Average	Variance (%)
David Prouty High School	Pre	2L 4' T8 Ice Cube	344	11	59	58.7	0.5%
	Pre	2L 8' T12 HO Ind	48	9	227	228.1	-0.5%
	Pre	2L 4' T12 Wrap	80	9	80	79.0	1.3%
	Pre	8' 4L 4' T8 Ind Ice Cube	38	9	112	117.7	-5.1%
	Pre	1L 4' T12 Wrap	40	9	50	49.9	0.2%
	Pre	150W HPS	8	5	188	188.2	-0.1%
	Pre	250W MH	5	5	295	188.2	36.2%
	Pre	4L 2x4 T8	11	6	112	111.8	0.1%
	Pre	400W HPS Fld TR	2	2	465	448.5	3.5%
	Pre	75W Incan A Sconce	12	6	75	75.0	0.0%
Knox Trail Elementary School	Pre	4L 2x4 T12 DS	565	11	160	160.1	-0.1%
	Pre	4L 2x4 T12	70	10	160	159.9	0.1%
	Pre	400W MH	24	8	458	449.4	1.9%
	Pre	400W MH Area DA	13	6	458	450.8	1.6%
Wire Village Elementary School	Pre	8’ 4L 4’ T5 U/D DS	178	11	126	126.0	0.0%
	Pre	400W MH Area DA	38	8	458	448.4	2.1%
	Pre	2L 42W 4P RC 10”	146	11	100	99.3	0.7%
	Pre	8' 4L 4' T8 U/D	105	9	112	111.0	0.9%
	Pre	8L 42W 4P High Bay	24	8	376	377.6	-0.4%
	Pre	3L 2x2 U T8	75	11	89	88.5	0.6%
	Pre	90W Incan Fld Pendant	37	9	90	90.0	0.0%
	Pre	2L 4' T8 Strip	24	8	59	58.1	1.5%
	Pre	12' 6L 4' T8 U/D DS	103	10	178	171.1	3.9%
	Pre	400W MH Area DA	23	8	458	449.0	2.0%
East Brookfield Elementary School	Pre	8L 42W 4P High Bay	24	8	376	377.0	-0.3%
	Pre	2L 32W 4P RC 10”	128	10	62	65.2	-5.2%
	Pre	3L 2x2 U T8	83	10	89	87.2	2.0%
	Pre	8' 4L 4' T8 U/D DS	20	8	112	112.5	-0.4%
	Pre	175W MH WP	9	5	215	164.6	23.4%
School Administration Building	Pre	8' 4L 4' T12 Wrap	23	8	160	158.6	0.9%
	Pre	2L 4' T12 Wrap	14	7	80	79.1	1.1%

Table 17: Post-retrofit Lighting Measurements

Facility	Retrofit Period	Fixture Type	Population Size	Sample Quantity	Wattage (W)		
					Expected	Measured Average	Variance (%)
David Prouty High School	Post	LED3 2x4	213	11	34	17.2	48.9%
	Post	LED3 High Bay FS	30	8	108	131.6	-21.9%
	Post	LED3 8' Wrap	4	3	42	24.0	42.3%
Knox Trail Elementary School	Post	LED3 2x4	659	11	34	33.3	1.0%
	Post	LED3 High Bay FS	24	7	108	132.4	-22.6%
	Post	LED Area2	13	6	116	119.0	-2.6%
Wire Village Elementary School	Post	LED3 2x2	802	11	27	21.3	21.8%
	Post	LED Area2	38	9	116	113.0	2.6%
	Post	LED3 2x4	79	10	34	28.9	14.0%
	Post	LED3 High Bay FS	24	8	108	132.1	-22.3%
East Brookfield Elementary School	Post	LED3 2x2	497	11	27	17.7	34.8%
	Post	LED3 2x4	124	10	34	24.9	25.9%
	Post	LED Area2	23	8	116	109.8	5.4%
	Post	LED 6L Biax Retro	13	6	102	102.0	0.0%
School Administration Building	Post	LED1 8' Wrap	23	8	52	52.0	0.0%
	Post	LED1 4' Wrap	18	7	25	25.0	0.0%

Realized savings for this measure equal **$125,635**, which is greater than the guaranteed energy savings of **$111,581** by **$14,055**. These savings consist of 748,263 kWh of electric energy savings **(Table 18)**.

Table 18: Lighting Retrofit and Controls Savings for Annual Period 1

Location	Guaranteed Savings		Realized Savings		Savings Variance
	Electric Energy Savings (kWh)	Total Guaranteed Savings	Electric Energy Savings (kWh)	Total Realized Savings	
David Prouty High School	62,932	$10,775	66,897	$11,454	$679
Knox Trail Middle School	270,172	$44,940	302,987	$50,398	$5,458
Wire Village Elementary School	198,982	$32,490	228,076	$37,241	$4,751
East Brookfield Elementary School	119,609	$21,040	137,934	$24,264	$3,223
School Administration Building	12,675	$2,336	12,369	$2,279	($56)
Total	**664,371**	**$111,581**	**748,263**	**$125,635**	**$14,055**

4.2.2. Plug Load Controls

A plug load management system was installed at Spencer-East Brookfield RSD to reduce unnecessary electric energy usage when electronic equipment is not in use by scheduling the equipment to turn off at night and on weekends. Savings for this measure are verified through the short-term logging of the runtime hours for the equipment connected to the plug load control system. Siemens installed BERT systems on 107 devices, which is 2 devices less than the quantity listed in section 4.2.7 of the Contract. Post-retrofit quantities and scheduled run hours are shown

in Table 19. The trend reports provided by the plug load installer showed that the schedules are less than the expected schedules, which results in realized savings excess for this measure.

Table 19: Plug Load Controls Parameters

Equipment	Electric Demand (W)	David Prouty High School			Knox Trail Middle School			Wire Village School			Brooks Elementary School			School Administration Building		
		Qty	Hrs/Wk	kWh Savings	Qty	Hrs/Wk	kWh Savings	Qty	Hrs/Wk	kWh Savings	Qty	Hrs/Wk	kWh Savings	Qty	Hrs/Wk	kWh Savings
AC Unit*	8	7	107	156	0	0	0	0	0	0	0	0	0	7	107	157
Large Printer/Copier	40	5	108	1,122	0	0	0	3	108	676	2	108	448	2	105	439
Hot/Cold Water Dispenser	61	2	108	687	0	0	0	0	0	0	1	107	339	2	108	684
Medium Printer	10	3	106	166	0	0	0	1	108	56	1	108	56	1	107	56
Projector	8	7	108	315	9	108	405	18	108	811	0	0	0	0	0	0
Soda Vending	320	1	108	1,802	1	108	1,802	0	0	0	0	0	0	0	0	0
Smartboard	32	1	108	180	0	0	0	0	0	0	0	0	0	0	0	0
Large Coffee	44	1	108	248	0	0	0	0	0	0	0	0	0	0	0	0
Charging Cart	35	0	0	0	21	108	4,129	5	108	986	6	108	1,183	0	0	0
TVMonitor	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		27		4,676	31		6,336	27		2,528	10		2,026	12		1,335

* Data Period 7/5/21 - 7/12/21 (Summer)
All Other Data Period 3/15/21 - 3/29/21

Grand Total kWh Savings:	**16,901**
Grand Total Meter Quantity:	**107**

Total savings for this measure equal **$2,870**, which is greater than the guaranteed savings of **$2,002** by **$867**. These savings consist of 16,901 kWh of electrical energy savings (Table 20)

Table 20: Plug Load Controls Savings for Annual Period 1

Location	Guaranteed Savings		Realized Savings		Savings Variance
	Electric Energy Savings (kWh)	Total Guaranteed Savings	Electric Energy Savings (kWh)	Total Realized Savings	
David Prouty High School	3,937	$674	4,676	$801	$126
Knox Trail Middle School	4,311	$717	6,336	$1,054	$337
Wire Village Elementary School	1,761	$288	2,528	$413	$125
East Brookfield Elementary School	776	$137	2,026	$356	$220
School Administration Building	1,015	$187	1,335	$246	$59
Total	**11,800**	**$2,002**	**16,901**	**$2,870**	**$867**

4.2.3. Building Envelope Improvements

Siemens installed building envelope improvements consisting of door weather stripping, roof-wall air Sealing and other air sealing. Building envelope improvements reduce infiltration of unconditioned outside air, resulting in natural gas savings and electric cooling savings. Energy savings for this measure were verified by visual inspection of the installed improvements. Several more locations for building envelope improvements were implemented than expected, which resulted in significantly higher savings at David Prouty HS and Knox Trail MS. Realized Savings for this FIM for Annual Period 1 equaled **$12,282** which is greater than the Guaranteed Savings **$8,772** by **$3,510** (Table 21). These savings consist of 9,717 therms of natural gas and 9,715 kWh of electrical energy.

Table 21: Building Envelope Improvements Savings for Annual Period 1

Location	Guaranteed Savings			Realized Savings			Savings Variance
	Electric Energy Savings (kWh)	Natural Gas Savings (Therms)	Total Guaranteed Savings	Electric Energy Savings (kWh)	Natural Gas Savings (Therms)	Total Realized Savings	
David Prouty High School	1,994	2,609	$3,617	2,216	2,899	$4,019	$402
Knox Trail Middle School	537	2,542	$2,656	1,001	4,738	$4,952	$2,295
Wire Village Elementary School	227	1,244	$1,279	252	1,378	$1,418	$138
East Brookfield Elementary School	0	638	$674	0	702	$743	$68
School Administration Building	2,956	0	$545	6,246	0	$1,151	$606
Total	**5,715**	**7,032**	**$8,772**	**9,715**	**9,717**	**$12,282**	**$3,510**

4.2.4. EMS Upgrades

Siemens installed several controls measures at all locations in this project. Unoccupied temperature setback controls were installed at all locations to reduce the heating and cooling requirements during unoccupied periods by reducing the space temperature setpoints during unoccupied periods. Additionally, demand control ventilation was installed at Knox Trail MS to vary the outdoor air intake to spaces according to current space occupancy requirements. Reducing the outdoor air intake results in less heat required to bring the supply air up to the temperature setpoint. Savings for both measures were verified through continuous monitoring of trend data of the space temperature setpoints for the unoccupied temperature setback, and the outdoor air damper position for the demand control ventilation.

During Annual Period 1, trends at Knox Trail MS and Wire Village ES showed significant setback during unoccupied hours for the heating and cooling season. Figures 3 and 4 show a sample of trends from November 2021 to illustrate the setpoint schedules implemented at Knox Trail and Wire Village. East Brookfield trend data demonstrated significantly less unoccupied temperature setback during the heating and cooling season.

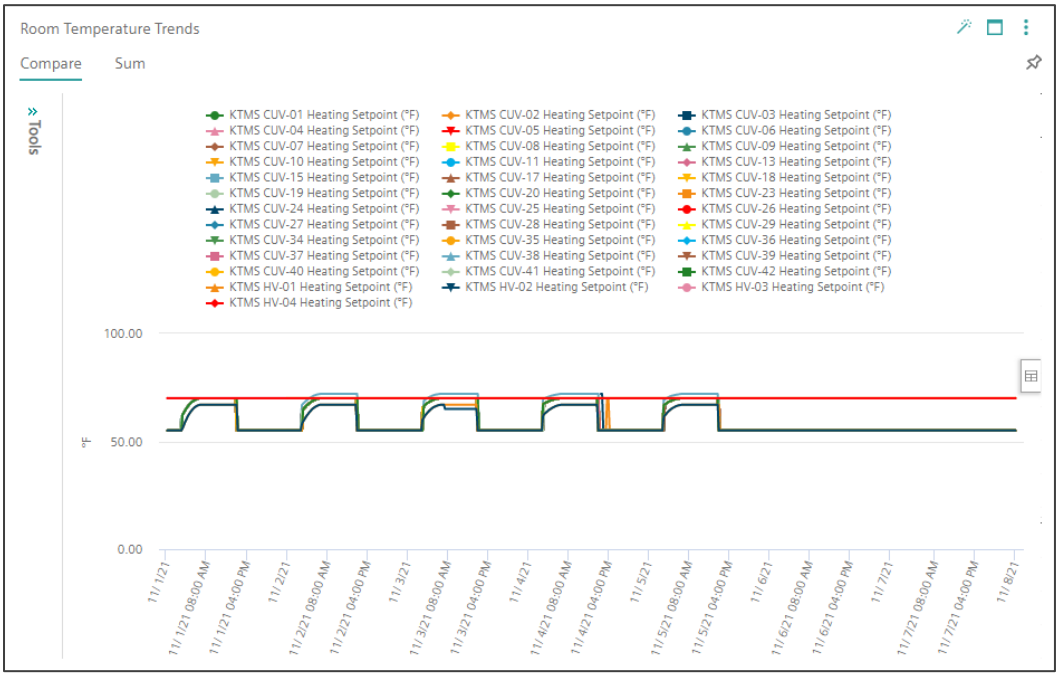

Figure 3: Knox Trail Unoccupied Temperature Setback Trends

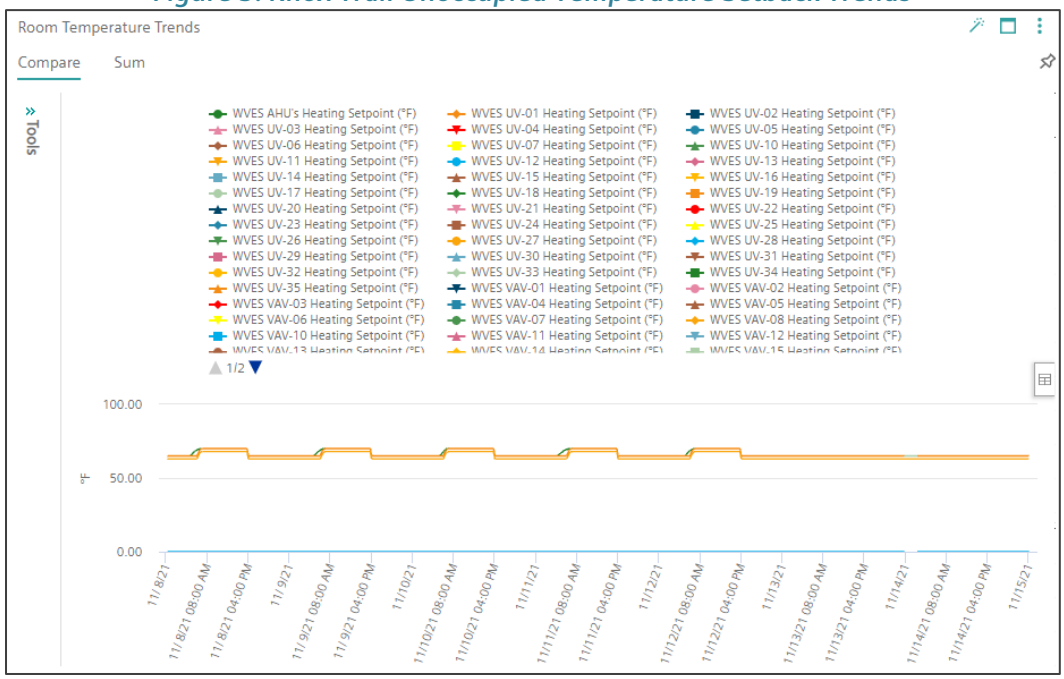

Figure 4: Wire Village Unoccupied Temperature Setback Trends

Setpoint temperature trends at East Brookfield show that the heating setpoints for the air handling units are varying between higher occupied setpoints temperatures and lower unoccupied setpoint as shown in **Figure 5**, but the setpoints for the classroom unit ventilators are not varying for unoccupied periods. This results in the overall space temperatures to not varying with occupancy as expected.

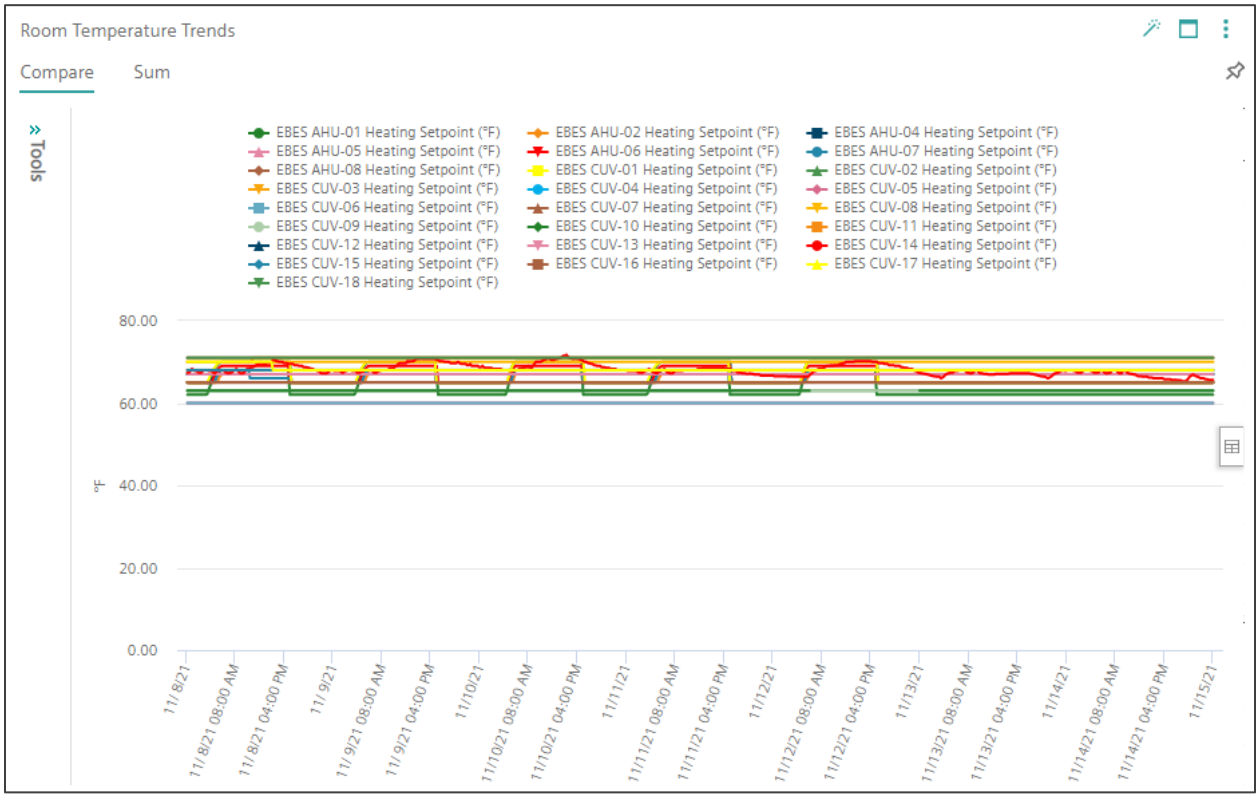

Figure 5: East Brookfield Unoccupied Temperature Setback Trends

Trends were unavailable for David Prouty HS and the administration building during Annual Period 1, and this measure was not able to be verified, so savings related to those buildings were considered to be zero. This significant loss of savings resulted in a savings shortfall for the entire energy management system upgrade measure, despite the other locations performing better than expected.

At Knox Trail MS, Siemens also installed demand control ventilation strategies to reduce the intake of outdoor air during low occupancy periods when high ventilation is not required. Carbon dioxide sensors were installed as upgrades to the existing space thermostats as combination thermostat units. These sensors inform the building controls system on the occupancy of the space to adjust the outdoor air intake to optimize CO2 levels. Verification of this measure was done via continuous trending of the outdoor air damper position.

During Annual Period 1, the unit ventilators at Knox Trail averaged an outdoor air damper position of 14.7% compared to the pre-retrofit damper position of 20%. This resulted in lower outdoor air intake which increased the average mixed air temperature of the unit ventilators during the heating season as shown in Table 22. Higher mixed air temperature means that less heat is required to bring the supply air up to the temperature required to meet the space temperature setpoint. Overall, this portion of the energy management system improvements resulted in 1,412 therms in natural gas savings.

Table 22: Demand Control Ventilation Operating Temperatures

Outside Air Temperature	Annual Operating Hours	Pre-retrofit Mixed Air Temperature	Post-retrofit Mixed Air Temperature
37.5	814	62	63
32.5	787	61	63
27.5	567	60	62
22.5	527	59	61
17.5	330	58	61
12.5	263	57	60
7.5	126	56	59
2.5	55	55	58

Total Savings for this measure are **$9,753**, which is short of the Guaranteed Savings of **$10,352** by **$599** (Table 23). These savings consist of **9,673** therms of natural gas savings.

Table 23: EMS Upgrades Savings for Annual Period 1

Location	Guaranteed Savings			Realized Savings		Savings Variance
	Electric Energy Savings (kWh)	Natural Gas Savings (Therms)	Total Guaranteed Savings	Natural Gas Savings (Therms)	Total Realized Savings	
David Prouty High School	0	880	$1,105	0	$0	($1,105)
Knox Trail Middle School	0	4,797	$4,845	5,933	$5,993	$1,148
Wire Village Elementary School	0	1,553	$1,551	3,310	$3,305	$1,754
East Brookfield Elementary School	0	1,717	$1,816	430	$455	($1,361)
School Administration Building	5,622	0	$1,036	0	$0	($1,036)
Total	**5,622**	**8,946**	**$10,352**	**9,673**	**$9,753**	**($599)**

4.2.5. Kitchen Hood Controls

Siemens installed Melink Intellihood control system on the kitchen hood systems at David Prouty HS, Knox Trail MS, Wire Village ES, and East Brookfield ES. This system provides occupancy-based ventilation at the kitchen hoods in each building. This allows the kitchen exhaust fans and make-up air units to provide a neutral space pressure while removing excess heat and smoke from the kitchen and reducing overall fan runtime and electrical energy consumption.

Energy savings for this measure were intended to be verified using post-retrofit measurements of fan electrical load at varying speeds. These tests were not completed, and therefore the savings for this measure are considered to not be achieved. The equipment was still installed as expected, and likely saving energy as expected, but those savings were not verified, and cannot be claimed

as realized savings. The lack of Realized Savings results in a shortfall for this measure equal to the guaranteed savings of $5,314 **(Table 24)**

Table 24: Kitchen Hood Controls Savings for Annual Period 1

Location	Guaranteed Savings			Realized Savings			Savings Variance
	Electric Energy Savings (kWh)	Natural Gas Savings (Therms)	Total Guaranteed Savings	Electric Energy Savings (kWh)	Natural Gas Savings (Therms)	Total Realized Savings	
David Prouty High School	2,266	638	$1,189	0	0	$0	($1,189)
Knox Trail Middle School	3,777	903	$1,540	0	0	$0	($1,540)
Wire Village Elementary School	3,777	903	$1,518	0	0	$0	($1,518)
East Brookfield Elementary School	2,266	631	$1,066	0	0	$0	($1,066)
Total	**12,087**	**3,074**	**$5,314**	**0**	**0**	**$0**	**($5,314)**

4.2.6. Walk-in Cooler Controls

Siemens installed new controls on the walk-in cooler systems at David Prouty HS, Knox Trail MS, Wire Village ES and East Brookfield ES. The existing walk-in refrigerator and freezer evaporator fans ran continuously, requiring more air to be blown across the evaporator than necessary. This measure consists of a control system that turns the fan off shortly after the desired temperature is reached and the compressor is turned off, resulting in electric energy Savings.

Verification of energy Savings achieved were based on continuous post-retrofit logging of the evaporator fan status during the first Annual Period. Evaporator fan status trends showed that during the first annual period the evaporator fans ran less often than the pre-retrofit runtime for most units, as shown in (**Table 25**)

Table 25: Walk-in Cooler Controls Parameters

Location	Unit Type	Pre-retrofit Calc EF Off %	%EF Post Runtime (on) From Data	Post-retrofit EF Off %	Evaporator Fan Wattage
David Prouty HS	Cooler	47%	44.68%	55.32%	114
David Prouty HS	Freezer	47%	66.84%	33.16%	190
East Brookfield ES	Cooler	47%	23.11%	76.89%	253
East Brookfield ES	Freezer	47%	50.21%	49.79%	253
Knox Trail MS	Cooler	47%	23.58%	76.42%	133
Knox Trail MS	Freezer	47%	100.00%	0.00%	253
Wire Village ES	Food Cooler	47%	23.94%	76.06%	266
Wire Village ES	Food Freezer	47%	85.54%	14.46%	253

Total Savings for this measure are **$6,258**, which is in excess of the Guaranteed Savings of **$5,663** by **$595** (Table 26). These Savings consist of **36,879** kWh of electrical energy Savings.

Table 26: Walk-in Cooler Controls Savings for Annual Period 1

Location	Guaranteed Savings		Realized Savings		Savings Variance
	Electric Energy Savings (kWh)	Total Guaranteed Savings	Electric Energy Savings (kWh)	Total Realized Savings	
David Prouty High School	7,693	$1,317	8,333	$1,427	$110
Knox Trail Middle School	6,494	$1,080	11,639	$1,936	$856
Wire Village Elementary School	9,689	$1,582	6,220	$1,016	($566)
East Brookfield Elementary School	9,572	$1,684	10,687	$1,880	$196
Total	**33,448**	**$5,663**	**36,879**	**$6,258**	**$595**

4.2.7. Boiler Upgrades

Siemens replaced the existing hot water boiler systems at East Brookfield and Wire Village with new high efficiency modulating condensing boilers. At Wire Village the three existing boilers were replaced with one four-million BTU input boiler, and the two existing boilers at East Brookfield were replaced with a 2.5 million BTU input capacity boiler. The boiler systems at Knox Trail and David Prouty, which previously operated using fuel oil, were replaced with new condensing boilers and the systems were converted to operate on natural gas. These high efficiency boilers are able to meet the heating needs for the facilities while consuming significantly less natural gas, or in the case of the fuel converted system, will use less total energy as well as saving on fuel unit costs.

Energy savings for this measure were verified using based on one-time post-retrofit combustion efficiency test. The combustion tests at each location resulted in slightly higher efficiencies than expected as shown in Table 27.

Table 27: Boiler Replacement Combustion Efficiency Results

Building	Test Date	Boiler 1 Measured Efficiency (%)		Boiler 2 Measured Efficiency (%)		Average Measured Efficiency (%)	Expected Efficiency (%)	Efficiency Variance
		High	Low	High	Low			
David Prouty High School	01/19/21	89.20	89.90	89.00	89.20	89.33	89.00	0.33
Knox Trail Middle School	01/20/21	92.10	95.60	88.40	88.80	91.23	89.00	2.23
Wire Village Elementary School	10/16/19	89.60	89.60	89.60	90.10	89.73	89.00	0.72
East Brookfield Elementary School	02/11/21	89.00	92.30	88.90	NA	90.07	89.00	1.07

Additionally, automated control strategies were implemented at David Prouty HS and Knox Trail MS to constantly adjust the boiler hot water supply temperature setpoint to match building heating load requirements. Reducing the boiler hot water supply temperature during periods of higher outdoor air temperatures allows for a significant reduction in fuel consumption, while still allowing the system to meet the heating load. This portion of the measure was verified through trend monitoring of the boiler supply temperature throughout Annual Period 1 to determine the total hot water reset.

During Annual Period 1, the hot water supply temperature data showed that the reset control strategies were implemented and were operating properly. At both schools, there was a clear decrease in hot water supply temperature as outdoor air temperature increased, with both schools showing a consistent lower setpoint of 138 °F, as shown in Figure 6 and Figure 7.

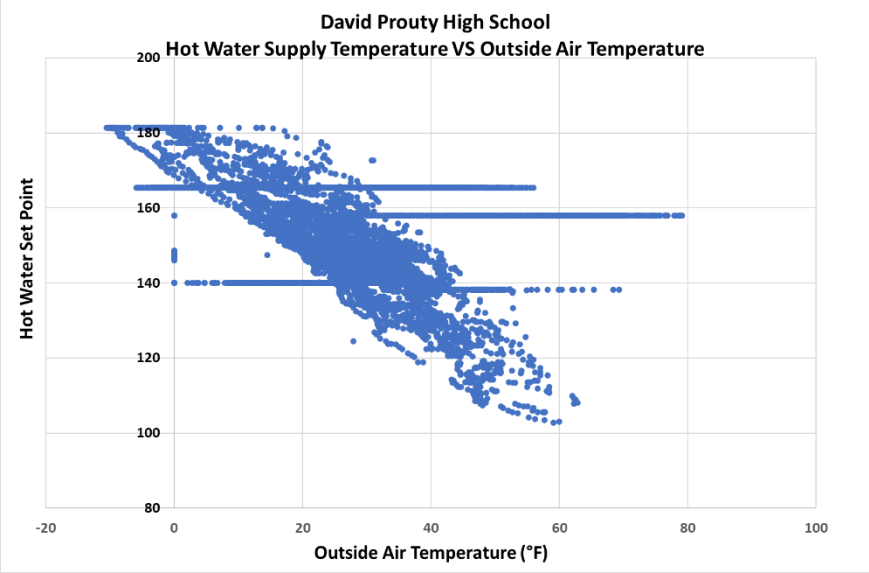

Figure 6: David Prouty Hot Water Reset Trends

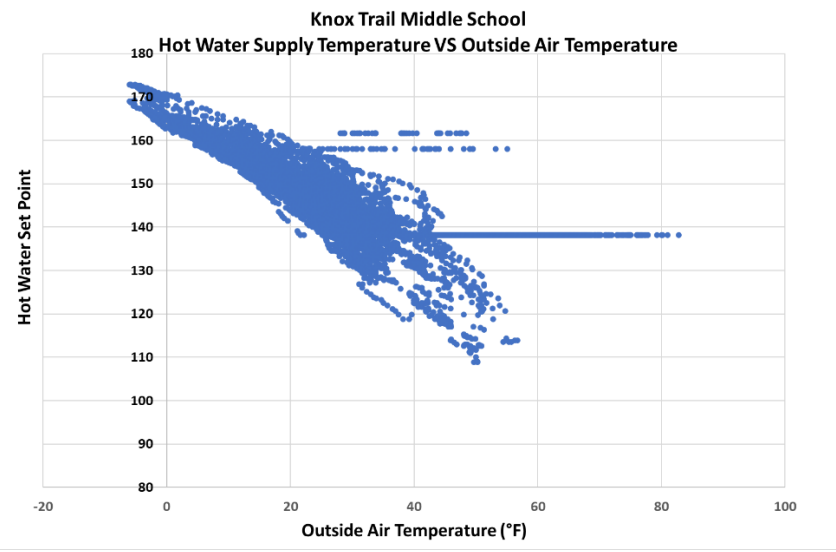

Figure 7: Knox Trail Hot Water Reset Trends

Total Savings for this measure are **$35,632**, which is in excess of the Guaranteed Savings of **$28,946** by **$6,687** (Table 28). These savings consist of **67,838** gallons of fuel oil savings, and 75,658 therms of natural gas cost, due to the conversion from fuel oil to natural gas.

Table 28: Boiler Upgrades: Replacement Savings for Annual Period 1

Location	Guaranteed Savings			Realized Savings			Savings Variance
	Natural Gas Savings (Therms)	#2 Fuel Oil Savings (Gal)	Total Guaranteed Savings	Natural Gas Savings (Therms)	#2 Fuel Oil Savings (Gal)	Total Realized Savings	
David Prouty High School	(42,164)	35,652	$11,949	(39,758)	35,652	$14,970	$3,021
Knox Trail Middle School	(40,450)	32,186	$16,048	(37,274)	32,186	$19,255	$3,208
Wire Village Elementary School	547	0	$546	777	0	$776	$230
East Brookfield Elementary School	381	0	$403	597	0	$632	$228
Total	**(81,686)**	**67,838**	**$28,946**	**(75,658)**	**67,838**	**$35,632**	**$6,687**

4.3. Option B Energy Savings

Realized Option B Savings for the current Annual Period amounted to **$4,715**, which is **$102** in excess of the guaranteed **$4,613** in Savings **(Table 29)**. Option B FIMs consist of premium efficiency motors and variable frequency drives.

Table 29: Option B Savings for Annual Period 1

Facility Improvement Measure	Electric Energy Savings (kWh)	Realized Savings	Guaranteed Savings	Savings Variance
Boiler Upgrade-Premium Efficiency Motors and VFDs	27,935	$4,715	$4,613	$102

4.3.1. Premium Efficiency Motors and Variable Frequency Drive

Siemens installed premium efficiency motors and variable frequency drives on the boiler system hot water pumps at David Prouty HS and Knox Trail MS. The variable frequency drive installation will operate the hot water pumps at lower speeds than pre-retrofit, which will reduce the energy consumption and higher efficiency motors will consume less energy due to their efficiency. Energy savings for this measure were intended to be verified via continuous trending of pump motor electric consumption. Based on the trend points available, pump motor speeds were trended and used to calculate the Realized Energy Savings.

During Annual Period 1, hot water pumps at David Prouty were observed to run more often than was originally estimated. These four pumps were expected to operate in a lead/lag control strategy varying the time between each pump in pairs of pumps serving each zone. Trend data showed that these pumps are often operating simultaneously, though still fluctuating in speed. This resulted in lower energy savings than expected, due to higher overall runtime, while still consuming less energy due to reduced motor speed (**Table 30**).

Table 30: David Prouty VFD Trend Results

Pump Motor Speed Range	DP Pump 1 Percentage Operating Time	DP Pump 2 Percentage Operating Time	DP Pump 3 Percentage Operating Time	DP Pump 4 Percentage Operating Time	Total Electrical Energy Usage (kWh)
100-90	11.50%	0.00%	77.27%	65.67%	15,033
90-80	17.42%	0.02%	16.51%	28.96%	4,773
80-70	3.11%	0.03%	2.13%	5.35%	552
70-60	4.78%	0.01%	0.00%	0.00%	180
60-50	22.38%	0.00%	0.00%	0.00%	509
50-40	14.66%	96.56%	0.00%	0.01%	1,618
40-30	0.00%	3.37%	0.00%	0.00%	24
30-20	5.02%	0.00%	4.09%	0.01%	23
20-10	0.01%	0.01%	0.00%	0.01%	0
0	21.12%	0.00%	0.00%	0.00%	0
				Total	22,711
				Pre-retrofit Usage	30,165
				Savings	7,454

Annual Period 1 trends showed that at Knox Trail, pumps one and three ran and supported the load for the boiler system, but pumps 2 and 4 did not run at all. These pumps were also expected to be operating on a lead-lag system, but this suggests that pumps 2 and 4 are used as back-up. Trends for the two operational pumps show that the drives are varying the speed of these pumps effectively, though both pumps operate within a small range of speeds (Table 31)

Table 31: Knox Trail VFD Trend Results

Pump Motor Speed Range	KT Pump 1 Percentage Operating Time	KT Pump 2 Percentage Operating Time	KT Pump 3 Percentage Operating Time	KT Pump 4 Percentage Operating Time	Total Electrical Energy Usage (kWh)
100-90	65.67%	0.00%	0.00%	0.00%	10,286
90-80	28.96%	0.00%	0.00%	0.00%	3,307
80-70	5.35%	0.00%	0.00%	0.00%	429
70-60	0.00%	0.00%	0.00%	0.00%	0
60-50	0.00%	0.00%	41.24%	0.00%	884
50-40	0.01%	0.00%	16.39%	0.00%	203
40-30	0.00%	0.00%	42.33%	0.00%	269
30-20	0.01%	0.00%	0.01%	0.00%	0
20-10	0.01%	0.00%	0.01%	0.00%	0
0	0.00%	0.00%	0.01%	0.00%	0
				Total	15,377
				Pre-retrofit Usage	30,105
				Savings	14,728

Total Savings for this measure are **$4,715**, which is in excess of the Guaranteed Savings of **$4,613** by **$102** (Table 32). These savings consist of **27,935** kWh of electrical energy savings.

Table 32: Premium Efficiency Motors and Variable Frequency Drive Savings for Annual Period 1

Location	Guaranteed Savings		Realized Savings		Savings Variance
	Electric Energy Savings (kWh)	Total Guaranteed Savings	Electric Energy Savings (kWh)	Total Realized Savings	
David Prouty High School	16,996	$2,910	14,071	$2,409	($501)
Knox Trail Middle School	10,241	$1,703	13,863	$2,306	$603
Total	**27,237**	**$4,613**	**27,935**	**$4,715**	**$102**

4.4. Operational Savings

In addition to energy savings, the Contract provided operational savings benefits to SEBRD. **(Table 33)**. All the operational savings are related to the lighting improvement measures. The installed lighting has longer lifespan than the previous lighting fixtures and will require less routine maintenance, reducing the amount of labor spent on fixture repairs. The operational savings at East Brookfield Elementary are lower than the guarantee listed in **Table 7** because of an error that resulted in part of the operational savings being counted in the energy savings and being counted in both places.

Table 33: Operational Savings for Annual Period 1

Description	Realized Operational Savings
Lighting Retrofit - East Brookfield Elementary	$1,500
Lighting Retrofit - David Prouty High School	$1,500
Lighting Retrofit - Knox Trail Middle School	$1,500
Lighting Retrofit - Wire Village Elementary School	$1,400
Lighting Retrofit - School Administration building	$100
Total	**$6,000**

5. Construction Savings

Construction Period Savings are the energy savings realized between the time a FIM is considered substantially complete and the project as a whole is considered substantially complete. During this time period, SEBRSD has beneficial use of the equipment and is, therefore, realizing Savings. Construction Period Savings for this project are not guaranteed. Realized Construction Period Savings are **$264,718** (Table 34).

Realized construction Savings for each FIM are calculated by prorating the Annual Period 1 realized Savings to the period of beneficial use based on one of the three following scaling methods:

Daily Scaling – Annual Period 1 realized Savings are split evenly across the number of days in the Annual Period to come up with daily savings; the construction Savings are the sum of the daily Savings based on the substantial completion date of each FIM and location.

$$Scaled\ Savings_{Daily} = \frac{Annual\ Period\ 1\ Realized\ Savings}{Days\ in\ Annual\ Period\ 1} \times Days\ of\ Beneficial\ Use$$

HDD-Based Scaling – For weather-dependent FIMs whose savings occur predominantly during the heating season, savings per Heating Degree Day (HDD) [1] are determined based on the Annual Period 1 Savings and the HDD value observed during Annual Period 1 for the Buffumville Lake, MA Global Historical Climatology Network weather station. The construction Savings are the sum of the HDD observed between each FIM's substantial completion date and the start of Annual Period 1 multiplied by the Annual Period 1 realized Savings per HDD.

$$Scaled\ Savings_{HDD} = \frac{Annual\ Period\ 1\ Realized\ Savings}{Annual\ Period\ 1\ Observed\ HDD} \times Period\ of\ Beneficial\ Use\ HDD$$

CDD-Based Scaling – For weather-dependent FIMs whose savings occur predominantly during the cooling season, savings per Cooling Degree Day (CDD) are determined based on the Annual Period 1 Savings and the CDD value observed during Annual Period 1 for the Buffumville Lake, MA Global Historical Climatology Network weather station. The construction Savings are the sum of the CDD observed between each FIM's substantial completion date and the start of Annual Period 1 multiplied by the Annual Period 1 realized Savings per CDD.

$$Scaled\ Savings_{CDD} = \frac{Annual\ Period\ 1\ Realized\ Savings}{Annual\ Period\ 1\ Observed\ CDD} \times Period\ of\ Beneficial\ Use\ CDD$$

[1] HDD and CDD are measurements designed to quantify the demand for energy needed to heat and cool a building respectively. They are calculated based on average daily temperatures observed at a local weather station based on a balance point of *65°F* as *HDD = 65°F – Daily Average Temperature* and *CDD = Daily Average Temperature – 65°F*.

Table 34: Construction Period Savings and Scaling Methods by FIM

Facility Improvement Measure	Completion Date	Scaling Method	Scaling Factor	Electric Energy Savings (kWh)	Electric Demand Savings (kW)	Natural Gas Savings (Therms)	Water Savings (kGal)	Realized Cost Savings ($)
Lighting Retrofit and Lighting Controls	02/01/20	Days	108%	807,714	0	0	$135,617	02/01/20
Plug Load Controls	11/01/20	Days	33%	5,556	0	0	$943	11/01/20
Building Envelope Improvements	12/15/19	HDD	203%	19,747	19,752	0	$24,966	12/15/19
EMS Upgrade	01/15/21	HDD	40%	0	3,859	0	$3,891	01/15/21
Kitchen Hood Controls	12/15/19	Days		0	0	0	$0	12/15/19
Walk-in Cooler Controls	10/31/20	Days	33%	12,226	0	0	$2,075	10/31/20
Boiler Replacement	10/15/19	HDD	241%	0	(182,312)	163,469	$85,864	10/15/19
Boiler Upgrade-Premium Efficency Motors and VFDs	10/15/19	HDD	241%	67,314	0	0	$11,362	10/15/19
Total	-	-	-	**912,558**	**(158,701)**	**163,469**	**$264,718**	-

Appendix A: FIM Measurements

Appendix A.1. Lighting

Table 35 and Table 36 show the pre-retrofit and post-retrofit measurements taken from a sample of the relevant population of lighting fixtures.

Table 35: Lighting Pre-retrofit Measurements

Location	Fixture Description	Population Size	Actual Sample Size	Expected kW	Measured Average kW	SAMPLE ENTRY START										
Administration	8' 4L 4' T12 Wrap	23	8	160	159	156	158	159	161	158	162	157	158			
Administration	2L 4' T12 Wrap	14	7	80	79	78	79	79	80	79	79	80				
David Prouty HS	2L 4' T8 Ice Cube	344	11	59	59	58	59	61	59	58	58	57	58	59	59	60
David Prouty HS	2L 8' T12 HO Ind	48	9	227	228	225	226	227	230	240	226	227	225	227		
David Prouty HS	2L 4' T12 Wrap	80	9	80	79	78	77	79	80	80	79	80	80	78		
David Prouty HS	8' 4L 4' T8 Ind Ice Cube	38	9	112	118	118	115	118	118	118	118	118	118	118		
David Prouty HS	1L 4' T12 Wrap	40	9	50	50	49	51	50	50	51	50	49	50	49		
David Prouty HS	150W HPS	8	5	188	188	188	188	188	189	188						
David Prouty HS	250W MH	5	5	295	188	188	188	188	189	188						
David Prouty HS	4L 2x4 T8	11	6	112	112	112	112	112	111	112	112					
David Prouty HS	400W HPS Fld TR	2	2	465	449	449	448									
David Prouty HS	75W Incan A Sconce	12	6	75	75	75	75	75	75	75	75					
East Brookfield ES	12' 6L 4' T8 U/D DS	103	10	178	171	170	167	168	169	174	175	175	175	170	168	
East Brookfield ES	400W MH Area DA	23	8	458	449	450	447	448	452	450	448	450	447			
East Brookfield ES	8L 42W 4P High Bay	24	8	376	377	377	376	376	380	378	376	375	378			
East Brookfield ES	2L 32W 4P RC 10"	128	10	62	65	66	65	64	66	66	61	66	66	66	66	
East Brookfield ES	3L 2x2 U T8	83	10	89	87	87	88	88	87	86	87	88	86	87	88	
East Brookfield ES	8' 4L 4' T8 U/D DS	20	8	112	113	112	113	113	113	112	111	113	113			
East Brookfield ES	175W MH WP	9	5	215	165	163	166	168	163	163						
Knox Trail MS	4L 2x4 T12 DS	565	11	160	160	159	163	161	158	158	158	162	158	163	161	160
Knox Trail MS	4L 2x4 T12	70	10	160	160	162	158	161	163	158	161	162	158	157	159	
Knox Trail MS	400W MH	24	8	458	449	450	448	448	452	450	449	450	448			
Knox Trail MS	400W MH Area DA	13	6	458	451	448	452	454	449	448	454					
Wire Village ES	8' 4L 4' T5 U/D DS	178	11	126	126	126	126	126	126	126	126	126	126	126	126	126
Wire Village ES	400W MH Area DA	38	8	458	448	447	448	448	450	450	449	447	448			
Wire Village ES	2L 42W 4P RC 10"	146	11	100	99	98	99	100	98	100	100	100	100	99	100	98
Wire Village ES	8' 4L 4' T8 U/D	105	9	112	111	111	112	111	111	111	111	111	110	111		
Wire Village ES	8L 42W 4P High Bay	24	8	376	378	380	376	376	376	378	376	379	380			
Wire Village ES	3L 2x2 U T8	75	11	89	88	88	89	89	88	89	89	89	90	87	86	89
Wire Village ES	90W Incan Fld Pendant	37	9	90	90	90	90	90	90	90	90	90	90	90		
Wire Village ES	2L 4' T8 Strip	24	8	59	58	56	56	58	59	60	57	59	60			

Table 36: Lighting Post-retrofit Measurements

Location	Fixture Description	Population Size	Actual Sample Size	Expected kW	Measured Average kW	SAMPLE ENTRY START										
Administration	LED1 8' Wrap	23	8	52	52	52	52	52	52	52	52	52	52			
Administration	LED1 4' Wrap	18	7	25	25	25	25	25	25	25	25	25				
David Prouty HS	LED3 2x4	213	11	34	17	21	21	16	16	16	16	16	17	17	16	17
David Prouty HS	LED3 High Bay FS	30	8	108	132	132	132	129	132	134	130	132	132			
David Prouty HS	LED3 8' Wrap	4	3	42	24	24	24	24								
East Brookfield ES	LED3 2x2	497	11	27	18	20	16	16	14	15	15	20	21	20	17	21
East Brookfield ES	LED3 2x4	124	10	34	25	22	23	36	34	33	33	17	17	17	17	
East Brookfield ES	LED Area2	23	8	116	110	110	109	110	110	109	110	110	110			
East Brookfield ES	LED 6L Biax Retro	13	6	102	102	102	102	102	102	102	102					
Knox Trail MS	LED3 2x4	659	11	34	33	34	32	32	32	32	32	32	34	34	36	36
Knox Trail MS	LED3 High Bay FS	24	7	108	132	132	133	132	132	133	132	133				
Knox Trail MS	LED Area2	13	6	116	119	120	119	119	119	118	119					
Wire Village ES	LED3 2x2	802	11	27	21	22	21	21	21	20	22	22	21	21	21	22
Wire Village ES	LED Area2	38	9	116	113	113	113	113	113	113	113	114	113	112		
Wire Village ES	LED3 2x4	79	10	34	29	38	38	32	32	17	17	32	34	32	17	
Wire Village ES	LED3 High Bay FS	24	8	108	132	132	132	132	132	132	133	131	133			

Appendix A.2. Boiler Test Results

The following figures are the boiler combustion efficiency tests taken to confirm the higher efficiencies of boiler installed as a part of this project.

Figure 8: Boiler Combustion Tests at David Prouty HS

Figure 9: Boiler Combustion Tests at East Brookfield ES

Figure 10: Boiler Combustion Tests at Knox Trail MS

Figure 11: Boiler Combustion Tests at Wire Village ES