

Egan Middle School Energy Modeling Results – Proposed Energy Efficiency Measures

January 13, 2017

Project Goals

The California Clean Energy Jobs Act (Proposition 39 or “Prop 39”) provides up to \$550 million per year to improve energy efficiency and increase the use of clean energy in public schools. Leveraging Prop 39 funds, California IOUs are running the Prop 39 Zero Net Energy (ZNE) Schools Pilot. The pilot is intended to address ZNE needs in schools on a comprehensive and sustainable basis through the period that Prop 39 funding is available and beyond. The pilot enables target setting, designing to the target energy footprint, building to the design, and post-construction monitoring, diagnosis and correction. Egan Middle School has enrolled in the PG&E Proposition 39 ZNE Schools Pilot in order to target ZNE. For the Pilot, funding from PG&E will cover the incremental cost of energy efficiency measures, not including the cost of solar photovoltaic (PV) systems. PG&E funding from the Pilot is not subject to the same cost effectiveness savings-to-investment ratio (SIR) requirements as the Prop 39 funding. As a Pilot School, Egan will serve as a “proof of concept” site, that by using Proposition 39 funding, ZNE retrofits of schools are feasible across California.

The Proposition 39 ZNE Schools Pilot Program defines ZNE as “Source Energy ZNE”. Source Energy ZNE accounts for the transmission and distribution losses of varying energy supplies beginning at their source, and is therefore higher than the ‘Site Energy’ which is equal to the natural gas and electricity used on site (i.e. utility bill energy use). Source energy conversion factors are 3.15 (electricity use use), 3.15 (exported renewable energy), and 1.09 (natural gas energy use), per the Department of Energy.

Modeling Process

In pursuit of the Program Goals, Integral Group has created the following energy models of Egan Middle School, Building K.

- Baseline energy model of the existing building
- Baseline energy model with proposed energy efficiency measures applied

These energy models were built using the EnergyPlus platform Openstudio v1.12 and weather data from the Mountain View Moffett Field TMY3 file.

Baseline Energy Model

A baseline energy model of Egan Middle School, Building K, in Los Altos Unified School District was created in order to simulate the energy use of the existing building. The baseline energy model was informed with data from the 11/2/2016 site visit, Title 24 historical code minimum values, and industry standards. The baseline energy model was calibrated to the overall energy use for the site based on the school’s historical 2012 utility bill data. Refer to the Egan Baseline Energy Use Report, dated November 17, 2016, for detailed information on the baseline energy model.

Since the Egan Baseline Energy Use Report, a few changes were made to the baseline that resulted in reduced baseline energy consumption. These changes are detailed below:

- Reduced domestic hot water usage – At the last design charrette, Egan staff pointed out that the domestic hot water seemed high. After analyzing the model and the utility data, it was discovered that the values used for domestic hot water consumption in the previous iteration were taking into account the entire campus, rather than just Building K. The domestic hot water values were therefore adjusted to better correspond with actual conditions.
- HVAC airside economizing – On the 11/2/2016 site visit, it was discovered that the current HVAC system makes use of airside economizing. However, this strategy was not included in the first iteration of the baseline. This feature was added to the new baseline model.

Solar Production

Early studies have already begun to look at preliminary prediction of energy generated on the site with a photovoltaic system based on available roof area and location. The facility can support up to 110 kW of solar on the building's roof using a standard efficiency solar panel systems and 80% roof cover. An array of this size would offset up to 150,000 kWh/yr, which would offset a building site energy use (EUI) of 19 kBtu/sf-yr.

Model Results Summary

Through review of existing building design and operation and discussions with Egan Middle School staff, Integral Group identified measures that would both meet the program's energy efficiency targets and that are in alignment with the school's future construction plans.

The measures have been presented as follows:

- A combined run ("Proposed") with the measures that are already part of the proposed design, as diagrammed in Figure 1:
Proposed measures package:
 - 1a. Replacement of skylights
 - 1b. Full lighting retrofit
 - 1c. Installation of daylighting controls
 - 1d. Replacement of the HVAC system
- Individual runs that are supplemental measures, that may be added to the current design:
 2. Reduced infiltration
 3. Installation of ceiling fans
 4. Installation of EnergyStar equipment
 5. Replacement of façade glazing
 6. High efficiency heat pumps
 7. Natural ventilation
 8. Night purge

The results of the measures in this second category have been applied to the baseline model to generate the source and site energy results in Figure 3 and Figure 2, respectively.

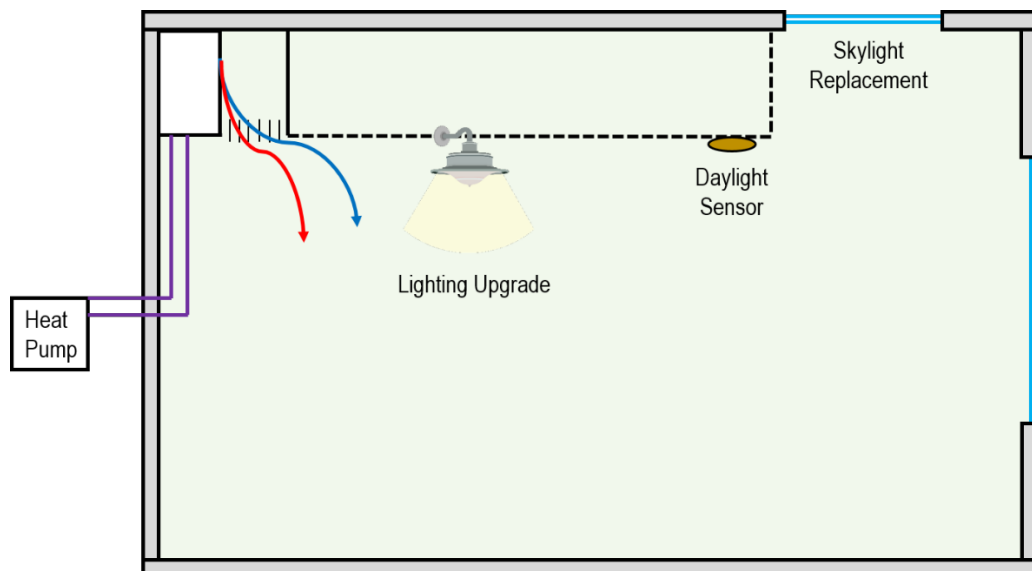


Figure 1: Proposed measures package

The results suggest that the currently proposed renovations allow Egan to target source ZNE-ready status, and the installation of a rooftop PV system would bring the project to ZNE status. The addition of a few supplemental EEMs would allow for a reduction in rooftop PV, therefore reducing the first cost of solar panels. This reduction would be on the magnitude of \$50,000 to \$100,000, depending on roof coverage and selection of supplemental EEMs. First cost of rooftop PV is presented in Table 4: Solar PV Generation Options. The most effective EEMs are use of EnergyStar equipment, high efficiency heat pumps, and night purge.

Note that the EEM runs below are added to the 'Proposed' Run, but packages of EEMs have not yet been modeled. Once the team selects the measures that best fit this project, packages of EEMs will be simulated.

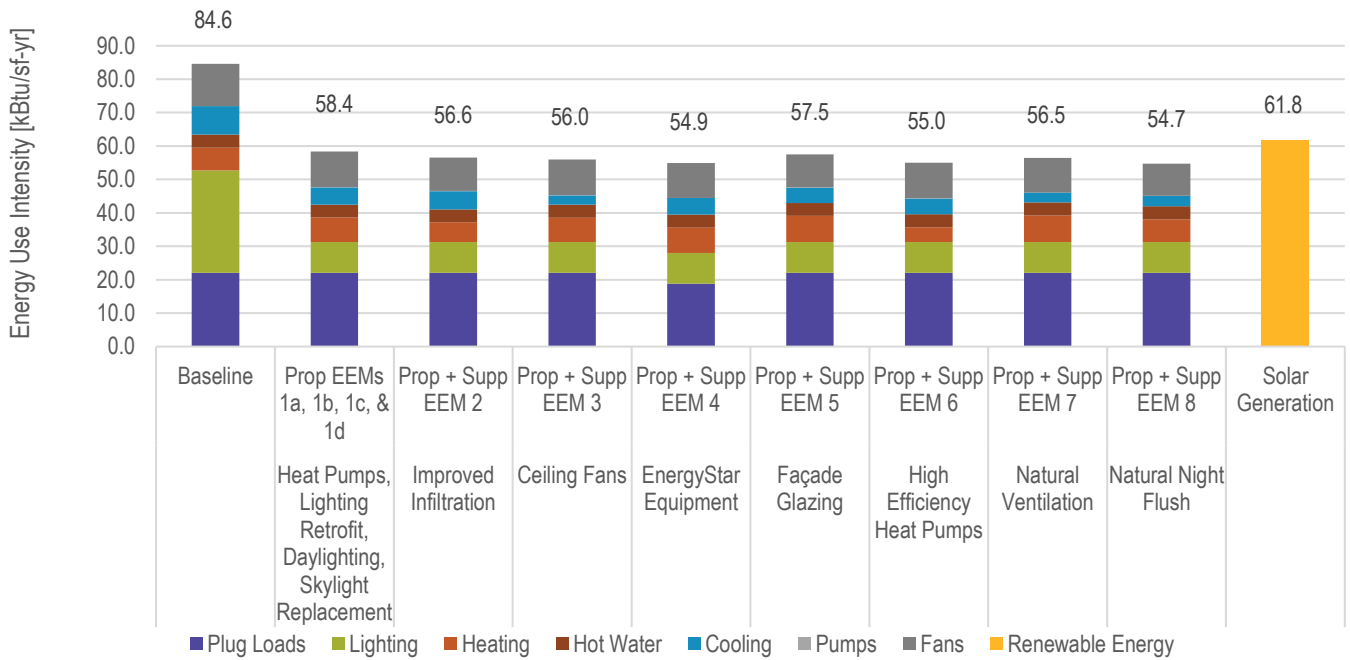


Figure 2: Source Energy Use Intensity

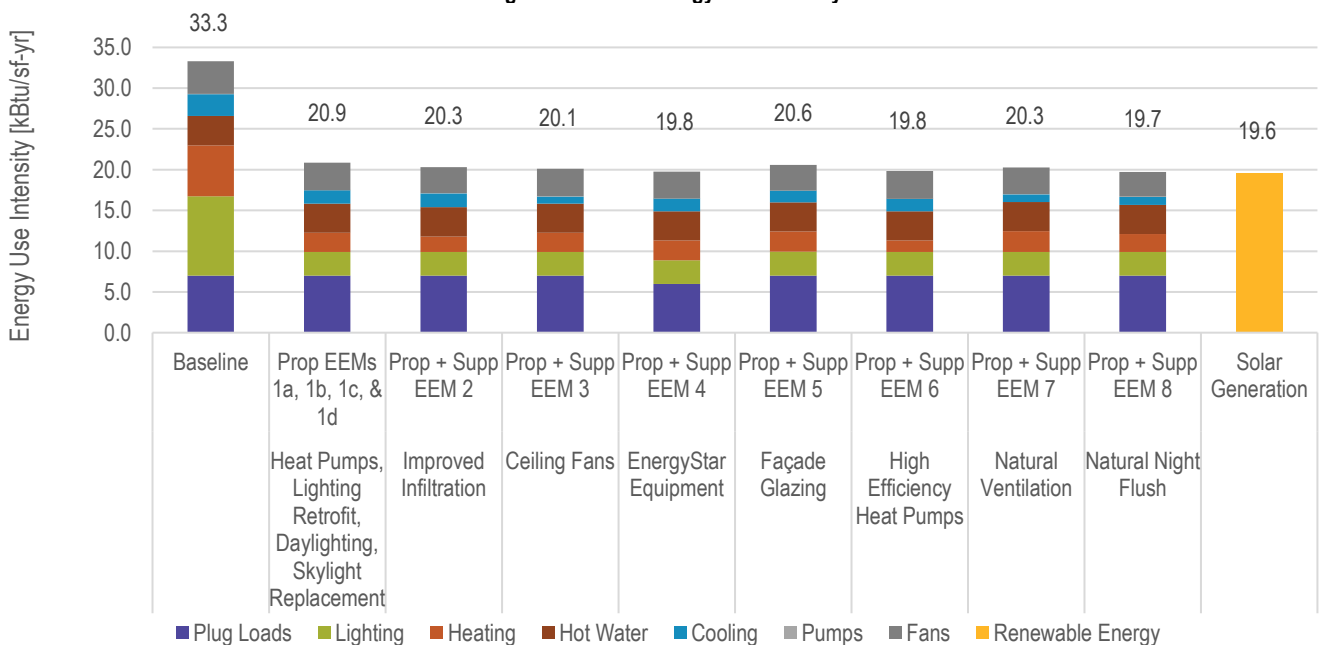


Figure 3: Site Energy Use Intensity

The site and source energy savings associated with the modeled measures can be found in Table 1. The measures are ordered based on building end use – HVAC, lighting, and plug loads. There are interactive effects between measures; as such, when a package of measures are modeled simultaneously, the energy savings will not be additive.

Table 1: Site and Source Energy Savings

EEM #	ZNE Measure	Site EUI (kBtu/sf)	Site Energy Results				Source Energy Results			
			Peak Demand Savings (kW)	Electricity Savings (kWh/yr)	Natural Gas Savings (therms/yr)	Total Energy Savings (kBtu/yr)	Peak Demand Savings (kW)	Electricity Savings (kWh/yr)	Natural Gas Savings (therms/yr)	Total Energy Savings (kBtu/yr)
			Baseline	Baseline	33.3	0	0	0	0	0
Proposed EEMs 1a, 1b, 1c, & 1d	Replace existing package air handler units with new heat pump system, full lighting retrofit, install daylighting controls, replace skylights	20.9	23	48,400	1,700	335,100	72	152,500	1,900	710,300
Proposed + EEM 2	Reduce infiltration	20.3	25	52,800	1,700	350,200	79	166,300	1,900	757,400
Proposed + EEM 3	Install ceiling fans for expanded thermal comfort	20.1	23	54,300	1,700	355,300	72	171,000	1,900	773,500
Proposed + EEM 4	Install Energy Star classroom and kitchen equipment	19.8	26	57,000	1,700	364,500	83	179,600	1,900	802,800
Proposed + EEM 5	Replace façade glazing	20.6	23	50,500	1,700	342,300	73	159,100	1,900	732,800
Proposed + EEM 6	Upgrade to high efficiency heat pumps	19.8	45	56,600	1,700	363,100	142	178,300	1,900	798,400
Proposed + EEM 7	Implement natural ventilation strategies	20.3	23	53,100	1,700	351,200	73	167,300	1,900	760,800
Proposed + EEM 8	Implement night purge strategies	19.7	22	57,500	1,700	366,200	71	181,100	1,900	807,900

The financial metrics for the modeled measures can be found in Table 2. Measures with an SIR of greater than 1.05 are eligible to be funded by the school district's Proposition 39 allocation funding. It is also possible to package measures together in order to meet the SIR requirement. Assumptions related to each measure's costs can be found in Table 3.

Table 2: Financial Metrics for Modeled Measures

EEM #	ZNE Measure	Site Energy Cost Savings	Measure Cost
		(\$/yr)	(\$)
Baseline	Baseline	-	-
Proposed EEMs 1a, 1b, 1c, & 1d	Replace existing package air handler units with new heat pump system, full lighting retrofit, install daylighting controls, replace skylights	\$8,700	\$221,080
Proposed + EEM 2	Reduce infiltration	\$9,400	\$240,165
Proposed + EEM 3	Install ceiling fans for expanded thermal comfort	\$9,600	\$247,798
Proposed + EEM 4	Install Energy Star classroom and kitchen equipment	\$10,000	\$310,506
Proposed + EEM 5	Replace façade glazing	\$9,000	\$588,958
Proposed + EEM 6	Upgrade to high efficiency heat pumps	\$10,000	\$288,684
Proposed + EEM 7	Implement natural ventilation strategies	\$9,400	\$221,080
Proposed + EEM 8	Implement night purge strategies	\$10,100	\$221,080

Table 3: Cost Assumptions for Modeled Measures

EEM #	Energy Efficiency Measures	Unit Cost	Unit	Measure Cost
		(\$)		(\$)
Proposed 1a, 1b, 1c, & 1d	Proposed Renovation	Total		\$221,080
	<i>Replace existing package air handler units with new heat pump system</i>	\$2,500	Ton	\$76,982
	<i>Full lighting retrofit</i>	\$350	Light Fixture	\$73,850
	<i>Install daylighting controls</i>	\$1,400	Classroom	\$21,000
	<i>Replace skylights</i>	\$114	SF Skylight	\$49,248
2	Reduce infiltration	\$0.71	SF Floor	\$19,085
3	Install ceiling fans for expanded thermal comfort	\$1	SF Floor	\$26,718
4	Install Energy Star classroom and kitchen equipment	Total		\$89,426
	<i>Computer</i>	\$370	Computer	\$74,000
	<i>Refrigerator</i>	\$3,018	Refrigerator	\$6,036
	<i>Projector</i>	\$486	Projector	\$7,290
	<i>Printer</i>	\$140	Printer	\$2,100
5	Replace façade glazing	\$114	SF Glass	\$367,878
6	Upgrade to high efficiency heat pumps	\$250	Ton	\$6,146
7	Implement natural ventilation strategies			\$0
8	Implement night purge strategies			\$0
PV	Solar PV	\$4	Watt	Varies

Increasing the number of EEMs implemented will reduce the future installed solar PV cost. Site EUI and PV cost for different rooftop solar PV options are outlined in Table 4: Solar PV Generation Options.

Table 4: Solar PV Generation Options

Option	Roof cover	PV Size	Site EUI	PV Cost
	(%)	(kW)	(kBtu/sf)	(\$)
Large	80	110	19.6	\$440,000
Medium	75	103	18.4	\$410,000
Small	70	96	17.2	\$380,000

Proposed EEM – 1a: Replace existing package air handler units with new HVAC systems

Existing

Egan is heated and cooled by 20 rooftop package units (Carrier 48HJD005/6), each with a cooling EER of 11 and thermal efficiency of 80%, assumed to have decreased to 72% due to equipment degradation over time.

Proposed

The current design includes a retrofit of the existing HVAC system to Variable Air Volume (VAV) with air-cooled DX units.

This measure was modeled by replacing the rooftop package units with heat pumps with a cooling efficiency of SEER-15.8 and a heating efficiency of COP-2.4, as per specification.

Measure Interactions

This measure was packaged with all other proposed measures.

Proposed EEM – 1b: Reduce installed lighting power density with a full lighting retrofit

Existing

Egan's classrooms, library, computer room, and lounge contain 32W fluorescent T8 lights. Corridors are illuminated with wall mounted fluorescent T-12 lamps. The average lighting power density (LPD) across the entire building is 1.2 W/sf, indicating significant opportunity for energy savings from higher efficiency lamps.

Proposed

The current design includes replacement of fluorescent lamp fixtures with low wattage LED fixtures. The latest California energy code (Title 24-2016) requires that the replacement fixtures be dimmable and include daylight sensors for the most efficient operation.

This measure was modeled by reducing the lighting power density by about 25% in all spaces. There is opportunity to reduce the light power density even further if desired.

Measure Interactions

This measure was packaged with all other proposed measures. A reduction in lighting energy will result in increased heating energy and reduced cooling energy required for the building.

Proposed EEM – 1c: Install daylighting controls

Existing

The lighting system in the classrooms do not include daylight sensors which results in lights remaining on at all times when occupied.

Proposed

The current design includes installation of daylighting controls in spaces to allow for interior lighting to dim or turn off when a sensor detects a certain amount of natural light entering the space.

This measure was modeled by implementing daylighting controls to illuminate a space to 45 fc.

Measure Interactions

This measure was packaged with all other proposed measures. Packaging this measure with Proposed EEM-1b will reduce the first cost of this measure compared to implementing this measure alone.

Proposed EEM – 1d: Replace skylights

Existing

Each classroom in Egan has a Kalwall prefabricated flat skylight.

Proposed

The current design includes replacement of the existing skylights with new Kalwall skylights with improved thermal performance.

This measure was modeled by adjusting the skylight U-value to 0.53, SHGC to 0.38, and visible transmittance to 0.2, as per specification.

Measure Interactions

This measure was packaged with all other proposed measures.

Supplemental EEM – 2: Reduce infiltration

Existing

Egan's current envelope has fairly high infiltration rates due to its age and construction.

Suggested

It is recommended that Egan's envelope be sealed with Aeroseal to reduce air leakage, lowering the risk of unnecessary heating and cooling. Conduct blower door test to confirm new building infiltration rate.

This measure was modeled by reducing the infiltration rate to 0.15 cfm/sf of façade.

Measure Interactions

This measure was packaged with all proposed measures. Envelope commissioning through thermography and infiltration testing can assist in identifying conditioned air leakage, which will in turn lower heating energy consumption. This measure can be packaged with EEM-6 in order to reduce peak heating and cooling loads, thereby potentially saving on first costs by reducing the size of the new HVAC system.

Supplemental EEM – 3: Install ceiling fans for expanded thermal comfort

Existing

Cooling is provided by the rooftop package units (Carrier 48HJD005/6) with a cooling EER of 11.

Suggested

Ceiling fans offer a more efficient way to provide comfort than the existing cooling system. High volume low speed fans achieve high efficiency by making use of a large swept area. This allows a larger volume of air to be agitated at lower fan speeds. They allow the thermostat setpoint to be raised when in cooling mode, while maintaining similar comfort levels for occupants.

This measure was modeled by increasing the cooling set point to 77 deg F during occupied times for all spaces.

Measure Interactions

This measure was packaged with all proposed measures. This measure can be packaged with EEM-6 in order to reduce peak heating and cooling loads, thereby potentially saving on first costs by reducing the size of the new HVAC system.

Supplemental EEM – 4: Install Energy Star classroom and kitchen equipment

Existing

Egan has a kitchenette with a gas oven, two refrigerators, and two microwaves. Egan also has a computer lab with approximately 15 computers, along with several classrooms that also contain laptops. There is additional equipment in other buildings that are outside the scope of this project.

Suggested

It is recommended that Egan's equipment be replaced with Energy Star certified equipment or equipment that is 15% more efficient than industry standard. In general, Energy Star equipment can range from 20% - 40% more efficient than typical equipment. This measure will help reduce plug load energy, which accounts for approximately 22% of the total building's energy use.

This measure was modeled by reducing the equipment plug load density by 15% compared to the baseline model.

Measure Interactions

This measure was packaged with all proposed measures. A reduction in plug load energy will result in increased heating energy and reduced cooling energy required for the building.

Supplemental EEM – 5: Replace façade glazing

Existing

Egan's current envelope consists of Kawneer curtain window systems with fairly low thermal performance properties.

Suggested

It is recommended that the window systems be replaced with higher performance glazing.

This measure was modeled by adjusting the façade glazing U-value to 0.53 and SHGC to 0.38.

Measure Interactions

This measure was packaged with all proposed measures. This measure can be packaged with EEM-6 in order to reduce peak heating and cooling loads, thereby potentially saving on first costs by reducing the size of the new HVAC system. This can be packaged with EEM-6 or EEM-7 to better enable natural ventilation or night purge strategies.

Supplemental EEM – 6: Upgrade to high efficiency HVAC systems

Existing

Egan is heated and cooled by 20 rooftop package units (Carrier 48HJD005/6), each with a cooling EER of 11 and thermal efficiency of 80%, assumed to have decreased to 72% due to equipment degradation over time. As stated in the proposed EEMs, the current design includes a retrofit of the existing HVAC system to Variable Air Volume (VAV) with air-cooled DX units with a cooling efficiency of SEER-15.8 and a heating efficiency of COP-2.4.

Suggested

It is recommended that the new design use heat pumps with even higher efficiencies than currently designed: targeting a cooling SEER-16.6 and a heating COP-4.0.

This measure was modeled by replacing the rooftop package units with heat pumps with a cooling efficiency of SEER-16.5 and a heating efficiency of COP-4, as per specification.

Measure Interactions

This measure was packaged with all proposed measures.

Supplemental EEM – 7: Introduce natural ventilation strategies

Existing

Many rooms at Egan have operable windows. Cooling is provided by the rooftop package units (Carrier 48HJD005/6) with a cooling EER of 11.

Suggested

Occupants have comfort levels enhanced when given access to operable windows. To reduce energy use, fans should be turned “off” when operable windows are open and when mechanical heating and cooling are not required.

This measure was modeled by allowing operable windows to be opened when the outdoor temperature is between 69 and 75 deg F during occupied hours.

Measure Interactions

This measure was packaged with all proposed measures. This measure can be packaged with EEM-6 in order to reduce peak heating and cooling loads, thereby potentially saving on first costs by reducing the size of the new HVAC system.

Supplemental EEM – 8: Introduce night purge strategies

Existing

Many rooms at Egan have operable windows. Cooling is provided by the rooftop package units (Carrier 48HJD005/6) with a cooling EER of 11.

Suggested

Since the climate has a diurnal swing, a ‘night flush’ strategy can be employed to bring in cool air overnight and reduce daytime cooling energy. This EEM can either be manually controlled at the windows using natural ventilation or controlled using the ventilation system to cycle on at night.

This measure was modeled by allowing operable windows to be opened when the outdoor temperature is between 69 and 75 deg F during unoccupied hours.

Measure Interactions

This measure was packaged with all proposed measures. This measure can be packaged with EEM-6 in order to reduce peak heating and cooling loads, thereby potentially saving on first costs by reducing the size of the new HVAC system.

Next Steps

- Hold design charrette with staff from Integral Group, PG&E, Resource Refocus, and Egan Middle School on January 20th, 2017
- Create energy model with recommended energy efficiency measure package, informed by the design charrette
- Cadmus performs energy monitoring to establish baseline energy performance
- Egan Middle School applies for Proposition 39 funding for measures that have an SIR \geq 1.05
- Integral Group verifies installed energy efficiency measures
- PG&E provides measure buy-down money to Egan Middle School
- Cadmus performs post-installation energy monitoring

Appendix – Proposed Model Details

Proposed EEM – 1a: Replace existing package air handler units with new HVAC systems

Parameter	Description or Value
HVAC System Description	Heat Pumps
DX Cooling Efficiency	SEER-15.8
DX Heating Efficiency	COP-2.4

Proposed EEM – 1b: Reduce installed lighting power density with a full lighting retrofit

Space Type	Lighting [W/SF]
Classroom	0.96
Office - Enclosed	0.80
Lobby	1.20
Lounge	0.88
Conference Room	1.12
Computer Room	0.96
Library	0.96
Corridor	0.48
Restroom	0.48
Kitchenette	0.88
Mechanical	0.56
Storage	0.48
Stairwell	0.48
Elevator	0.48

Proposed EEM – 1c: Install daylighting controls

Parameter	Description or Value
Daylighting Control	45 fc

Proposed EEM – 1d: Replace skylights

Parameter	Description or Value
Skylight Assembly U-Value	0.53
Skylight SHGC	0.38
Skylight Visible Transmittance	0.2

Supplemental EEM – 2: Reduce infiltration

Parameter	Description or Value
Infiltration Rate	0.15 cfm/sf facade

Supplemental EEM – 3: Install ceiling fans for expanded thermal comfort

Parameter	Description or Value
Cooling Setpoint	77 deg F

Supplemental EEM – 4: Install Energy Star classroom and kitchen equipment

Space Type	Equipment Load Applied [W/SF]
Classroom	1.28
Office - Enclosed	0.68
Lounge	0.68
Computer Room	1.11
Kitchenette	0.85

Supplemental EEM – 5: Replace façade glazing

Parameter	Description or Value
Skylight Assembly U-Value	0.53
Skylight SHGC	0.38
Skylight Visible Transmittance	0.7

Supplemental EEM – 6: Upgrade to high efficiency HVAC systems

Parameter	Description or Value
HVAC System Description	Heat Pumps
DX Cooling Efficiency	SEER-16.5
DX Heating Efficiency	COP-4.0

Supplemental EEM – 7: Introduce natural ventilation strategies

Parameter	Description or Value
Open Area	86 sf
Min Indoor Temperature	67 deg F
Max Indoor Temperature	75 deg F
Max Allowable Difference Between Indoor and Outdoor Temperature	9 deg F
Min Outdoor Temperature	65 deg F
Max Outdoor Temperature	77 deg F
Max Wind Speed	40 m/s
Availability Schedule	5PM – 8AM

Supplemental EEM – 8: Introduce night purge strategies

Parameter	Description or Value
Open Area	86 sf
Min Indoor Temperature	67 deg F
Max Indoor Temperature	75 deg F
Max Allowable Difference Between Indoor and Outdoor Temperature	9 deg F
Min Outdoor Temperature	65 deg F
Max Outdoor Temperature	77 deg F
Max Wind Speed	40 m/s
Availability Schedule	8AM – 5PM



Egan Middle School EEM Package Results and Bid Comparison

By: Jared Landsman, Integral Group
Date: 3/7/2018

This memo contains the final energy and cost results for the EEM package selected for Egan Middle School recommended on January 31st, 2017. This memo also contains a comparison of the bid package and the final proposed package. The final proposed package includes the following:

- Base renovation
 - #1a: Replacement of existing package air handler units with new heat pump system
 - #1b: Full lighting retrofit
 - #1c: Installation of daylighting controls
 - #1d: Replacement of skylights
- Additional measures
 - #2: Infiltration reduction
 - #3: Installation of ceiling fans for expanded thermal comfort
 - #6: Upgrade to high efficiency heat pumps

The predicted annual energy consumption and energy cost for the current building are detailed below.

	Site Energy Results				
	Peak Demand	Electricity Use	Natural Gas Use	Site Energy Use	Annual Energy Cost*
	(kW)	(kWh/yr)	(therms/yr)	(kBtu/yr)	\$
Baseline	133	183,752	2,626	889,612	\$29,800

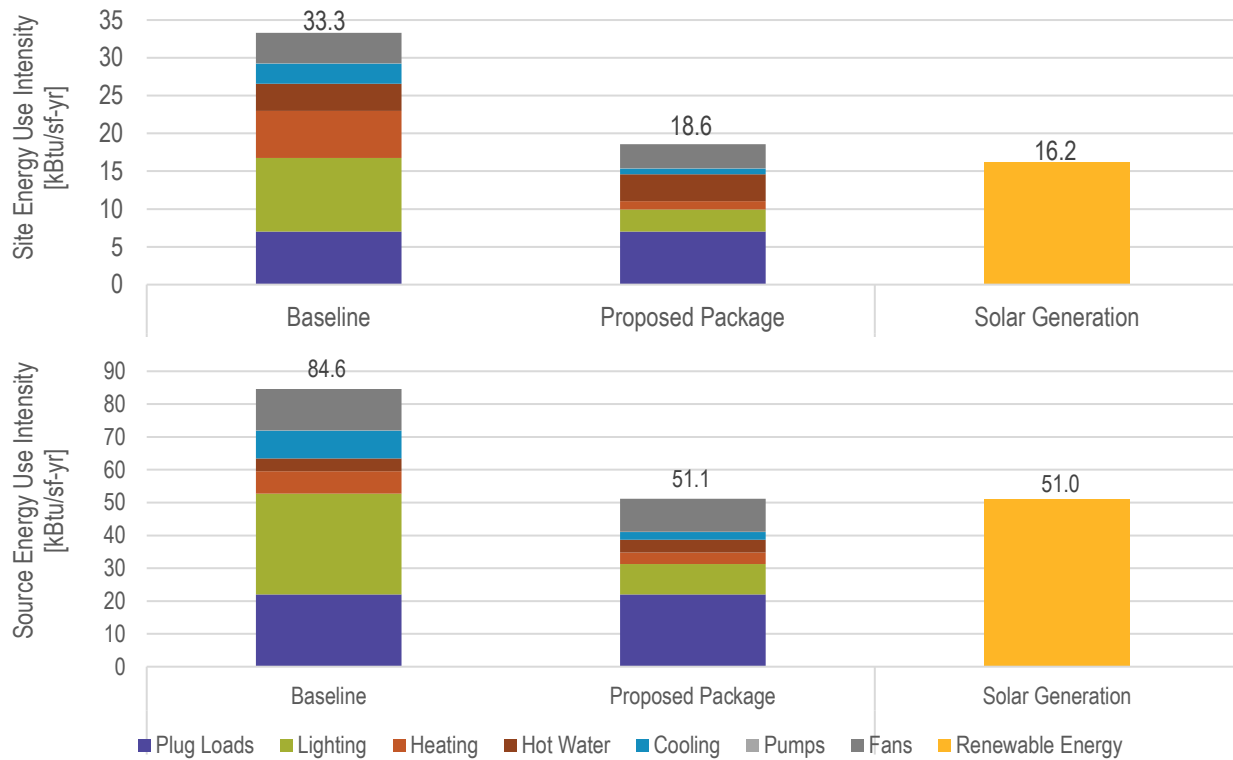
*Assumes \$0.15/kWh and \$0.86/therm

The site and source energy savings for the final EEM package are detailed below.

EEM #	ZNE Measure	EUI	Site Energy Results			
			Peak Demand Savings	Electricity Savings	Natural Gas Savings	Total Energy Savings
			(kW)	(kWh/yr)	(therms/yr)	(kBtu/yr)
Proposed EEMs 1a, 1b, 1c, & 1d + EEMs 2 & 3 & 6	Proposed Package	18.6	49	66,400	1,700	396,600

EEM #	ZNE Measure	Source Energy Results			
		Peak Demand Savings	Electricity Savings	Natural Gas Savings	Total Energy Savings
		(kW)	(kWh/yr)	(therms/yr)	(kBtu/yr)
Proposed EEMs 1a, 1b, 1c, & 1d + EEMs 2 & 3 & 6	Proposed Package	153	209,200	1,900	903,800

The site and source energy use intensity (EUI) can be seen below for both the existing building and the final proposed package. In addition, the solar generation EUI is presented with 66% roof coverage.



The energy cost savings, measure cost, & estimated SIR are presented for each individual measure, in addition to the complete proposed package.

EEM #	ZNE Measure	Energy Cost Savings*	Measure Cost	Simple Payback	SIR
		(\$/yr)	(\$)	(yrs)	
Proposed EEMs 1a, 1b, 1c, & 1d	Replace existing package air handler units with new heat pump system, full lighting retrofit, install daylighting controls, replace skylights	\$8,700	\$221,080	25	0.59
EEM 2	Reduce infiltration	\$700	\$19,085	27	0.55
EEM 3	Install ceiling fans for expanded thermal comfort	\$1,100	\$26,718	24	0.61
EEM 6	Upgrade to high efficiency heat pumps	\$900	\$5,901	7	2.18
Proposed EEMs 1a, 1b, 1c, & 1d + EEMs 2 & 3 & 6	Proposed Package	\$11,400	\$272,784	24	0.62

*Assumes \$0.15/kWh and \$0.86/therm

Different PV size options are detailed below. With the final EEM package, the building could achieve source ZNE with 66% roof coverage.

Option	Roof cover	PV Size	Site Energy Savings	Source Energy Savings	Energy Cost Savings	PV Cost
	(%)	(kW)	(kBtu/sf-yr)	(kBtu/sf-yr)	(\$/yr)	(\$)
Large	80	110	19.6	61.8	\$23,000	\$439,000
Medium	75	103	18.4	57.9	\$21,600	\$411,000
Small	70	96	17.2	54.1	\$20,200	\$384,000
Smallest	66	90	16.2	51.0	\$19,000	\$362,000

The final bid package does not describe the contents of the base bid, but it describes 5 “additive alternatives”. Below each description is Integral Group’s response.

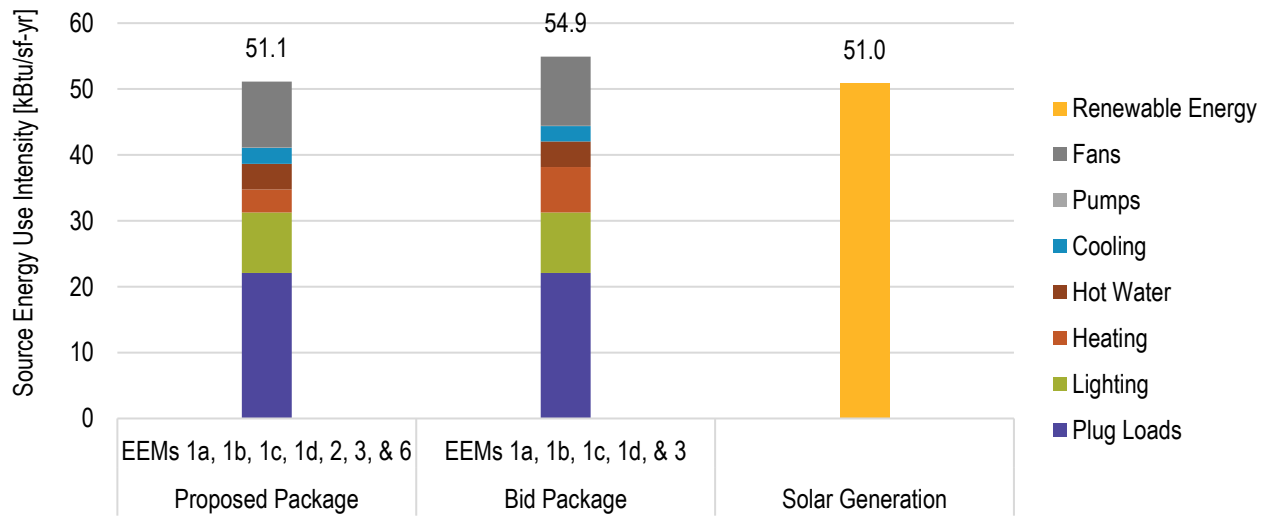
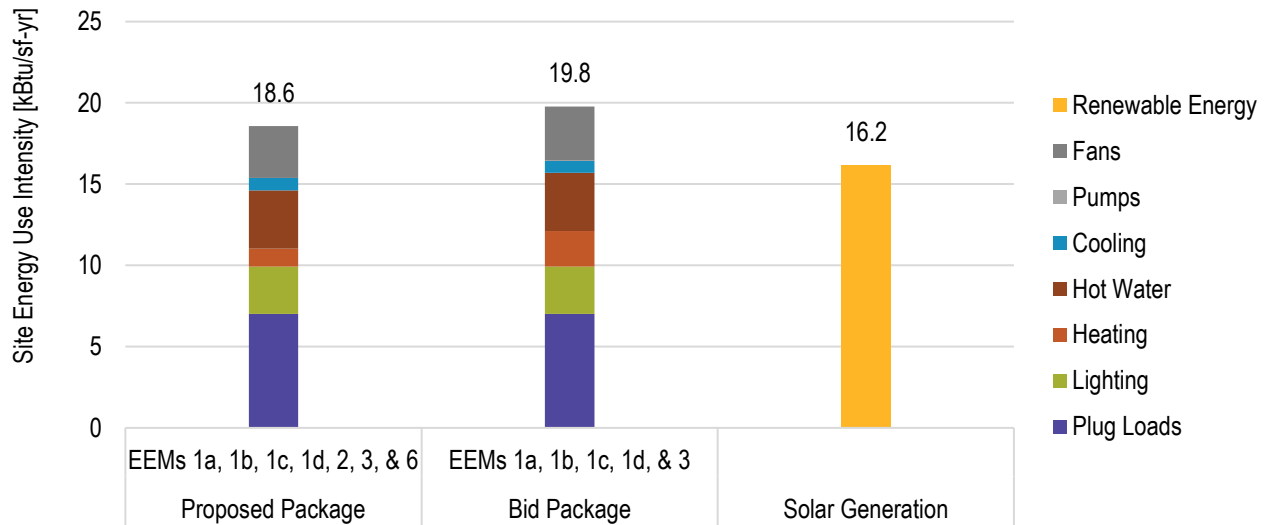
- Alternative #1: “Add 2 ceiling fans to each second floor classroom. Omit the diagonally opposite fans shown on the electrical plans. If taken this alternate shall supersede alternate 2”
 - Integral Group response: This corresponds to the proposed measure #3
- Alternative #2: “Add 4 ceiling fans to each second floor classroom as indicated on the electrical drawings. If taken this alternate shall supersede alternate 1”
 - Integral Group response: This corresponds to the proposed measure #3
- Alternative #3: “Upgrade the rooftop mechanical units per the equipment schedule on sheet M0.01.”
 - Integral Group response: This corresponds to the proposed measure #6. The proposed measure was an upgrade to a higher efficiency heat pump from the heat pumps listed in the base renovation (from cooling SEER-15.8 to SEER 16.6 and from heating COP-2.4 to COP-4.0). Sheet M0.01 has package heat pumps with the ORIGINAL efficiencies, therefore not upgraded to high efficiency.
- Alternative #4: “Install recessed downlights C, C1 and C2 in gypsum board ceiling, including cutting, patching and painting of ceiling. C, C1, C2 and H recessed downlights in suspended acoustical ceiling shall be in base bid.”
 - Integral Group response: This does not correspond to any of the proposed measures.
- Alternative #5: “Re-sealing of storefront windows”
 - Integral Group response: This corresponds to the proposed measure #2. However, the proposed measure also included using Aeroseal (or equivalent product) to reduce infiltration through the entire wall assembly, not just the window frames.

The site and source energy savings are detailed below for the final proposed package and for the bid package.

EEM #	Package	EUI	Site Energy Results		
			Electricity Savings	Natural Gas Savings	Total Energy Savings
			(kWh/yr)	(therms/yr)	(kBtu/yr)
Proposed EEMs 1a, 1b, 1c, & 1d + EEMs 2 & 3 & 6	Proposed Package	18.6	66,400	1,700	396,600
Proposed EEMs 1a, 1b, 1c, & 1d + EEM 3	Bid Package	19.8	57,000	1,700	361,200

EEM #	ZNE Measure	EUI	Source Energy Results		
			Electricity Savings	Natural Gas Savings	Total Energy Savings
			(kWh/yr)	(therms/yr)	(kBtu/yr)
Proposed EEMs 1a, 1b, 1c, & 1d + EEMs 2 & 3 & 6	Proposed Package	51.1	209,000	1,800	895,200
Proposed EEMs 1a, 1b, 1c, & 1d + EEM 3	Bid Package	54.9	179,000	1,800	793,700

The site and source energy use intensity (EUI) can be seen below for both the final proposed package and the bid package. In addition, the solar generation EUI is presented with 66% roof coverage. The graphs below suggest that Egan Middle School will be neither site nor source Zero Net Energy with the bid package.





Egan Middle School Final Package Results

By: Jared Landsman, Integral Group
Date: 11/6/2018

This memo contains the final energy and cost results for the package that was constructed at Egan Middle School. This memo also contains a comparison of the proposed package, bid package and constructed package. The constructed package includes the following energy efficiency measures:

- #1a: Replacement of existing package air handler units with new heat pump system
- #1b: Full lighting retrofit
- #1c: Installation of daylighting controls
- #1d: Replacement of skylights

The constructed package excludes the following EEMs which were proposed during design:

- #2: Infiltration reduction
- #3: Installation of ceiling fans for expanded thermal comfort
- #6: Upgrade to high efficiency heat pumps

The predicted annual energy consumption and energy cost for the pre-renovation building are detailed below.

	Site Energy Results				
	Peak Demand	Electricity Use	Natural Gas Use	Site Energy Use	Annual Energy Cost*
	(kW)	(kWh/yr)	(therms/yr)	(kBtu/yr)	\$
Baseline	133	183,752	2,626	889,612	\$29,800

*Assumes \$0.15/kWh and \$0.86/therm

The site and source energy savings are detailed below for the final proposed package and for the bid package.

EEM #	Package	EUI (kBtu/sf)	Site Energy Results			
			Electricity Savings (kWh/yr)	Natural Gas Savings (therms/yr)	Total Energy Savings (kBtu/yr)	Cost Savings (\$/yr)
			Baseline	Pre-Renovation	33.3	-
Proposed EEMs 1a, 1b, 1c, & 1d + EEMs 2 & 3 & 6	Proposed Package	18.6	66,400	1,700	396,600	\$11,400
Proposed EEMs 1a, 1b, 1c, & 1d + EEM 3	Bid Package	19.8	57,000	1,700	361,200	\$10,000
Proposed EEMs 1a, 1b, 1c, & 1d	Constructed Package	19.8	56,500	1,700	360,000	\$9,900

EEM #	ZNE Measure	EUI (kBtu/sf)	Source Energy Results		
			Electricity Savings (kWh/yr)	Natural Gas Savings (therms/yr)	Total Energy Savings (kBtu/yr)
			Baseline	Pre-Renovation	84.6
Proposed EEMs 1a, 1b, 1c, & 1d + EEMs 2 & 3 & 6	Proposed Package	51.1	209,000	1,800	895,200
Proposed EEMs 1a, 1b, 1c, & 1d + EEM 3	Bid Package	54.9	179,300	1,800	793,700
Proposed EEMs 1a, 1b, 1c, & 1d	Constructed Package	55.1	178,100	1,800	789,800

The site and source energy use intensity (EUI) can be seen below for the pre-renovation, proposed package, bid package, and constructed package. In addition, the solar generation EUI is presented with 66% roof coverage. The graphs below suggest that Egan Middle School will be just above source Zero Net Energy with the constructed package.

