

Introduction

The multifamily property located on Canal Street of Houston, TX is a 3,600 ft² facility which includes two stories and 8 units. The building's electric bill is approximately \$9,800 per year at an average rate of \$0.15/kWh. The property consumes on average 48,840 kWh of electricity annually with a carbon footprint of 21,100 kg CO₂ equivalent to 2,377 gallons of burned gasoline.

The owner of the multifamily property is interested in installing a solar PV + battery storage system and directly billing each tenant a fixed monthly payment for electricity. Interest in the project was sparked from the February 2021 winter storm in Texas that left many without power for days. The accompanying Level 2 Energy Assessment describes how the building is billed for electricity and many opportunities to reduce energy use.

Level 2 Energy Assessment

As part of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Level Two Energy Assessment, Sustainable Engineering has identified several no cost and low-cost energy conservation opportunities for the multifamily property, which included such measures as changing temperature set points on the programmable thermostat and replacing exterior door sweeps. Between the period of January 2021 and December 2021, tenants of the multifamily complex spent \$9,800 for 48,840 kWh of electricity. During the month of May 2022 energy monitoring equipment was placed in several units to obtain a representative sample of the electricity consumption by source (lighting, HVAC, heating, cooking, etc.). The data obtained from the monitoring equipment was used to develop a building energy model with the software eQUEST as noted in the Figure 1 to right.

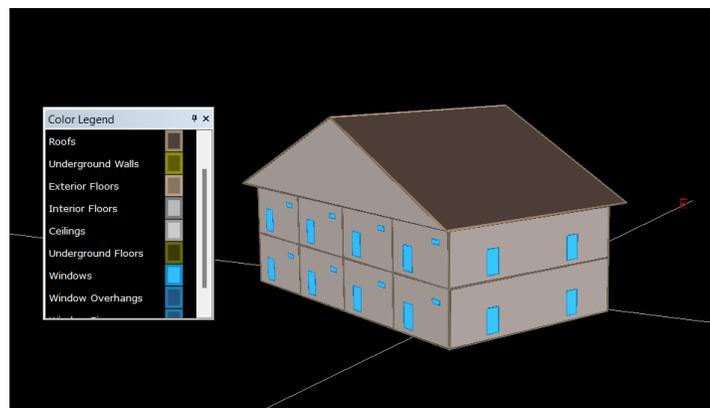


Figure 1: eQUEST Building Model

After a preliminary analysis, it appears that the potential savings of these no cost/low cost measures is approximately 14%, or approximately \$950 per year. The energy assessment revealed that the current HVAC units for apartment are oversized, leading to a lack of comfort for the tenants and excess energy use. Proper sized HVAC systems were modeled with heating being provided by a heat pump compared to resistive heating elements that are currently used for space heating. The new HVAC systems resulted in an additional 16% annual electricity savings, or approximately \$900 per year. These results are displayed in Figure 2 below. If the recommend Energy Efficiency Measures (EEM) are implemented the tenants or owner of the property could save nearly \$1,850 annually their electric bill.

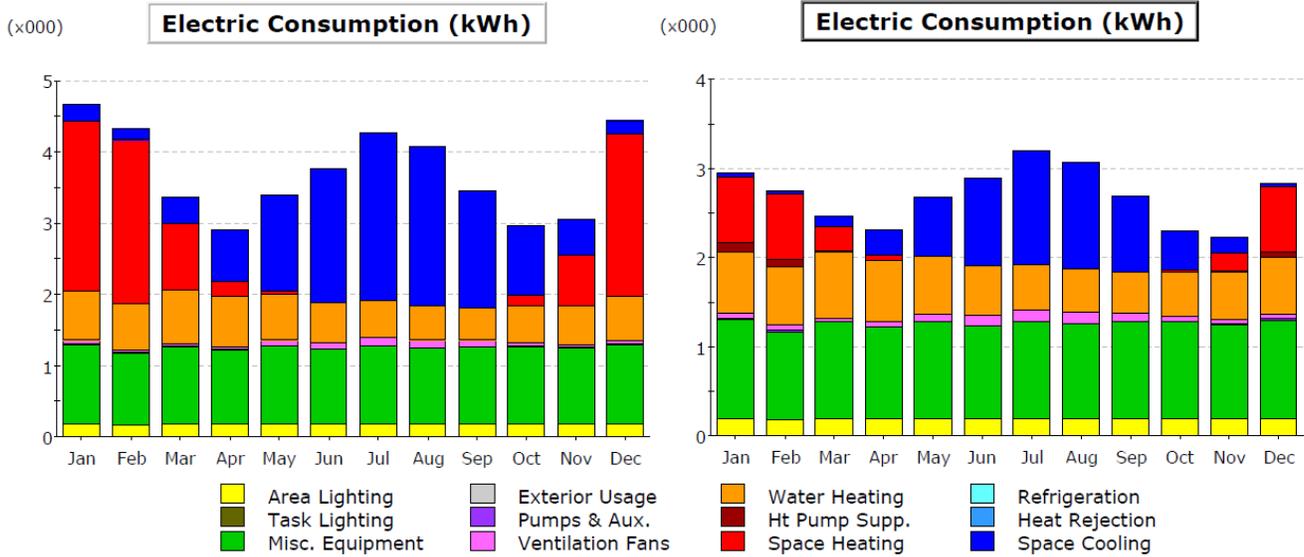


Figure 2: Monthly Baseline (Left) vs EEMs (Right) Electricity Consumption

Advantages of Solar PV + Battery Storage

A solar PV + battery storage system is being proposed as an option by providing peace of mind to tenants that reside in the multifamily building along with other environmental benefits. Residents pay an average of \$0.15/kWh for electricity, which is slightly above the average Texas retail electricity price. The roof of the building was chosen for the location to place the solar PV system with the north side of the building being used for the battery storage system, as observed in Figure 3. The proposal is to install a 23 kW DC PV system with micro-inverters and 89kWh or 134kWh of battery storage capacity for resiliency purposes. The battery storage capacity can be reduced substantially by implementing the recommended EEMs above, especially by installing the recommended HVAC unit that will reduce the peak demand of the property by 30%.

The solar PV system is expected to generate nearly 30,000 kWh of electricity per year offsetting the apartment's annual electricity use with a 61% - 92% renewable fraction and likewise reducing the overall carbon footprint. The renewable energy fraction can be observed in Table 1 located below in the financial section of the report. Furthermore, the solar PV + battery storage system is designed in such a way that tenants will have uninterrupted power for 8+ hours on batteries along and 7+ days on solar and batteries.



Figure 3: Solar PV + Battery Storage System Design

Key Financial Considerations

As noted by the owner of the property, their intent is to charge each tenant a flat rate electric bill as part of their monthly rent. A sensitivity analysis was conducted for the solar PV system and for the solar PV + battery storage system to determine the most appropriate monthly rate for electricity. When using the energy efficiency (EE) measures listed above the solar PV system can nearly generate the same amount of electricity that the building consumes annually “PV Production/Building Consumption”. As one would expect the higher monthly rate the owner charges tenants for electricity the more attractive the investment looks. Also observe the differences between the “PV + Battery” and “PV + Battery EE” systems in Table 1. By implementing the recommended EEMs the battery capacity needed to keep the building powered in the event of grid failure is reduced from 134kWh to 89kWh, thus reducing the capital costs of the project substantially.

Table 1: Solar PV & Solar PV + Battery Storage System Sensitivity Analysis

	PV	PV + Storage	PV EE	PV + Storage EE
PV Production/Building Consumption	61%		92%	
Unit Rate = \$75/month @ \$0.15/kWh				
Payback (Years)	11.1	22.7	11.1	18.5
Net Present Value	\$ 23,667	\$ (18,331)	\$ 23,667	\$ (1,261)
Unit Rate = \$100/month @ \$0.20/kWh				
Payback (Years)	8.5	18.2	8.5	14.6
Net Present Value	\$ 42,601	\$ 229	\$ 42,601	\$ 17,369
Unit Rate = \$125/month @ \$0.25/kWh				
Payback (Years)	6.8	15.2	6.8	12.1
Net Present Value	\$ 61,534	\$ 18,788	\$ 61,534	\$ 36,000
Unit Rate = \$150/month @ \$0.3/kWh				
Payback (Years)	5.7	14.5	5.7	10.3
Net Present Value	\$ 80,468	\$ 37,347	\$ 80,468	\$ 54,628

Final recommendations and energy savings opportunities are highlighted below in Table 2. It is recommended that the owner of the property charge each of the tenants \$150 per month flat rate fee for electricity. Incentives for the solar PV + battery storage system include the federal Investment Tax Credit (ITC) at 26% of total installation costs. While the heat pump system can utilize the [CenterPoint Energy - Residential and Hard-to-Reach Energy Efficiency Program](#). The CenterPoint Energy program allows for further savings on solar PV installations but was not used in this analysis. Subtle difference in financial values may be observed between Tables 1 & 2 as the sensitivity analysis considers such variables as inflation, loan interest rates, and future price increases. Overall, the owner of the multifamily property can expect to recoup their initial project cost shortly after 9 years and expect an additional \$12,000 in income annually for the remainder of the systems life. This can all be achieved while providing tenants with clean energy, resiliency, and peace of mind that they will always have power.

Table 2: Final Recommendations & Energy Savings

Measure Description	Annual Energy and Cost Savings			Payback with Incentive					
	Energy Cost Savings	Peak Demand Savings (kW)	Electricity [kWh]	Measure Cost	Potential Incentives	Measure Life (years)	Net Measure Cost	Simple ROI	Simple Payback (yr)
Low-Cost and No-Cost Recommendations									
HVAC Temperature Set Points	\$ 1,893		6,310				\$ -	immediate	-
Potential Capital Recommendations									
Install New Heat Pump System	\$ 1,800	7	6,000	\$ 16,000	\$ 3,013	20	\$ 12,988	14%	7.2
Solar PV + Battery Storage	\$ 8,998		29,993	\$139,805	\$ 36,349	25	\$103,456	9%	11.5
TOTALS (Recommended Measures)	\$ 12,691	7	42,303	\$155,805	\$ 39,362		116,443	11%	9.2