Greenhouse Gas, Energy and Cost Savings

The California Statewide Codes and Standards Program led the development of a cost-effectiveness study[1] for Energy Code reach codes that examined different performance-based approaches for new construction of low-rise residential (single-family and multi-family up to 3 stories) and non-residential building types. The study finds that all-electric buildings, even those with no other energy performance enhancements, provide significant greenhouse gas (GHG) reductions. The addition of energy efficiency and more solar can drive net energy use to nearly zero from some building types and GHG emissions to less than a third of a mixed-fuel 2019 State code compliant building.

The charts below compare total GHG emissions and net energy consumption (after onsite generation) of various strategies for typical building types.

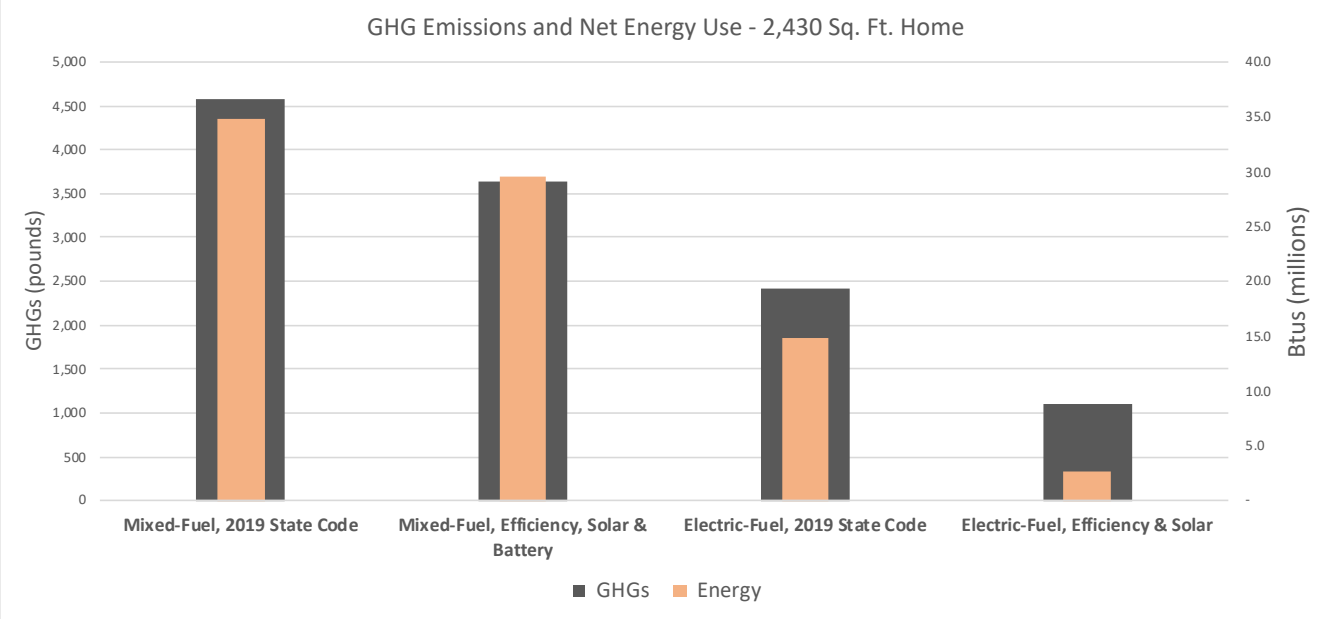


Figure 1: GHG and Energy Impact, Single Family Home

[1] https://localenergycodes.com/content/2019-local-energy-ordinances/

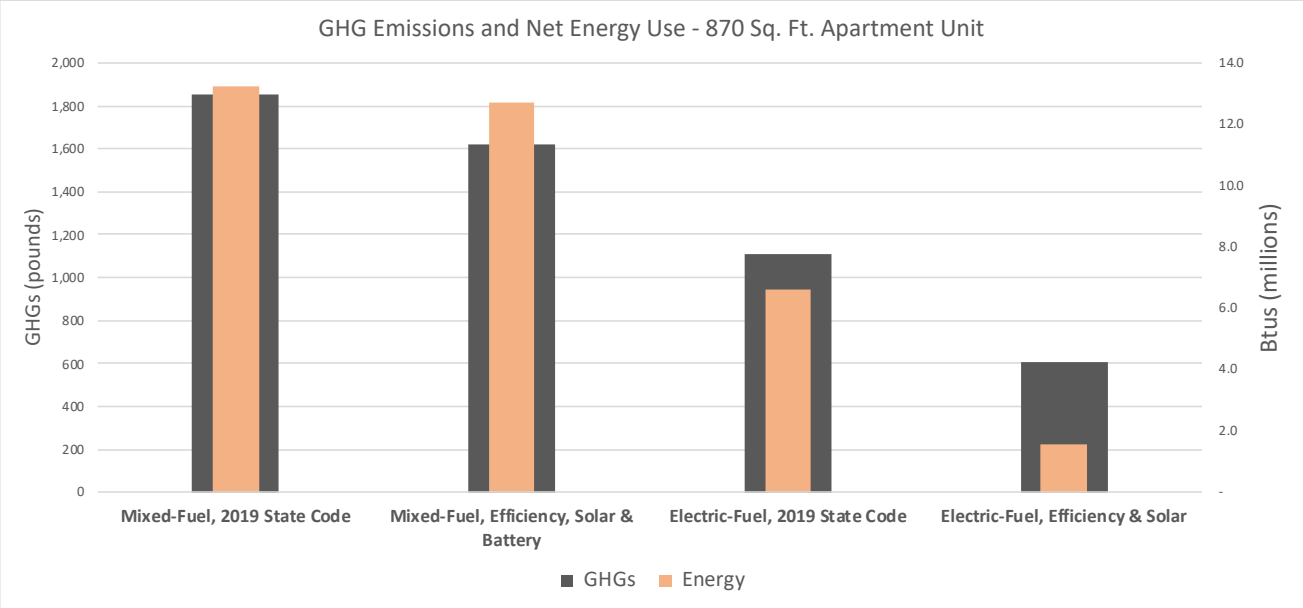


Figure 2: GHG and Energy Impacts, Low-Rise Multifamily Unit

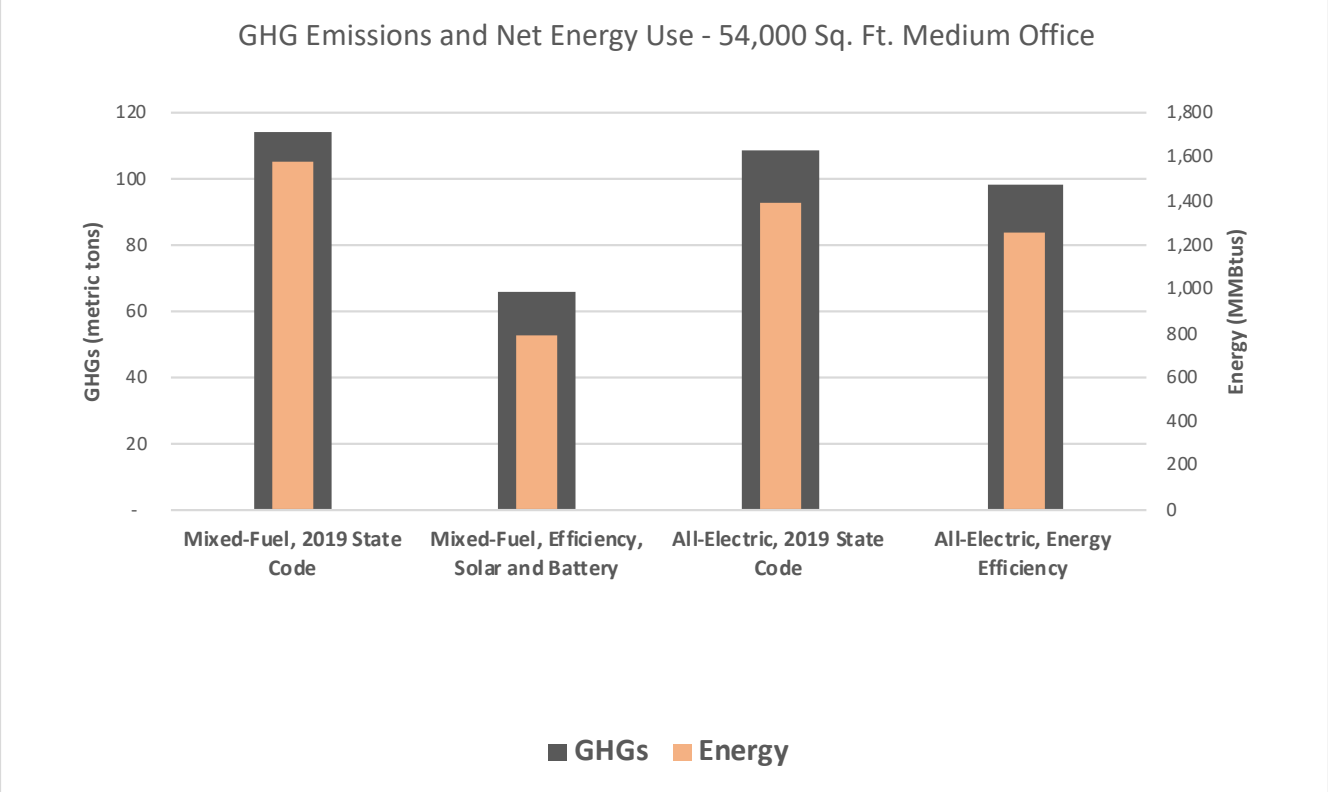


Figure 3: GHG and Energy Impact, Medium Office Building

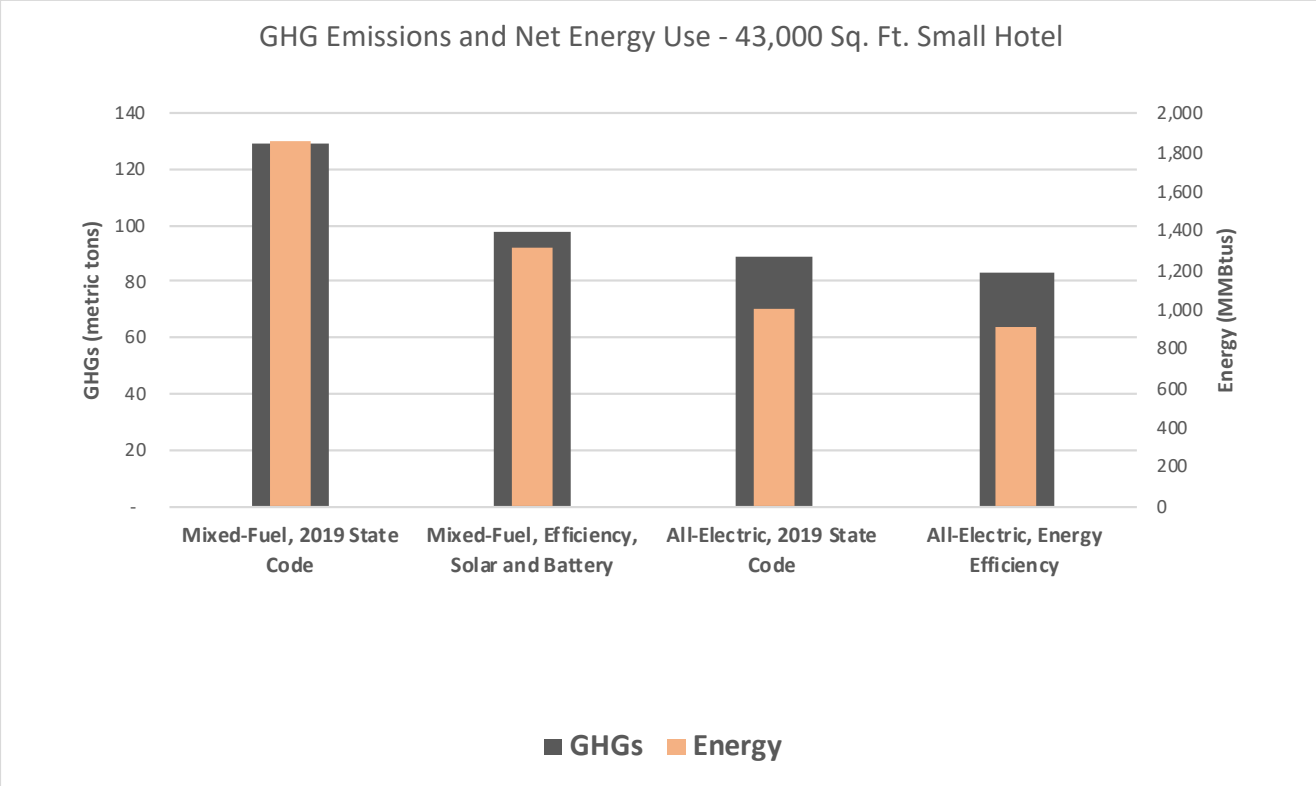


Figure 4: GHG and Energy Impact Small Hotel

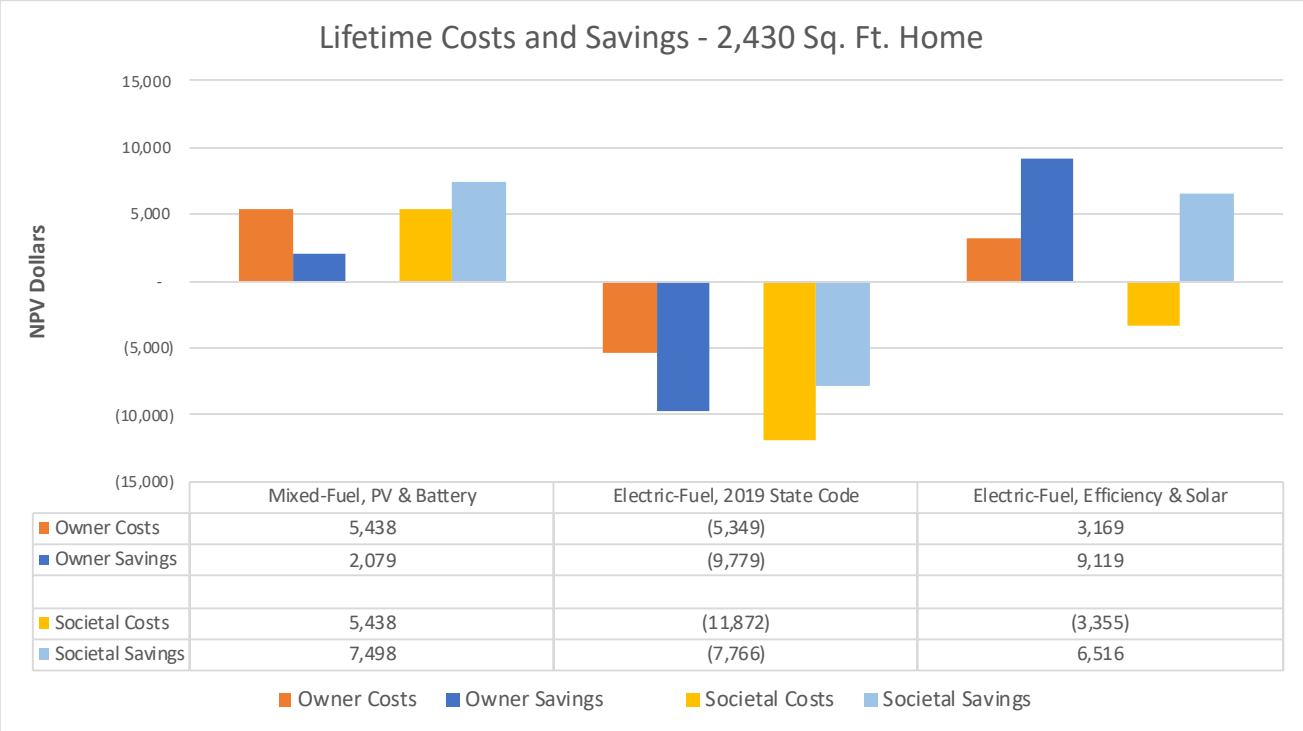
Economic Impacts

All-electric buildings are generally cheaper to build due to the elimination of running gas plumbing to the building. These lower first costs generally make all-electric construction more cost-effective on a life-cycle basis. This is particularly true for low-rise residential buildings, where it is also often increasingly more cost-effective for the owner to exceed the code by improving efficiency and adding solar. In fact, if one invests the savings from the gas infrastructure in additional PV capacity to offset more of the electricity load, in many cases the building is cost-effective for the owner and society from day one, meaning the building is both less expensive to build and cheaper to operate. This is shown as the "Neutral Cost" scenario in row 13 of Figure 6 below.

The charts below depict the incremental net present value costs and savings of various designs relative to a State-code-complaint mixed-fuel design. Note, each building type is examined from two perspectives: one from the owners/operator's point of view; the other from society's point of view[2]. The latter reflects benefits that accrue to other ratepayers and society.

[2] The societal point of view incorporates the time-dependent valuation (TDV) of energy, which is required by the CEC when determining cost-effectiveness.

In the following charts, Cost values less than zero indicate lower capital cost. Savings values less than zero indicate higher energy costs. "Mixed-Fuel, PV & Batter" corresponds with row 5 in the table; "Electric-Fuel, 2019 State Code" corresponds with row 11; and "Electric-Fuel, Efficiency & Solar" corresponds with row 12.

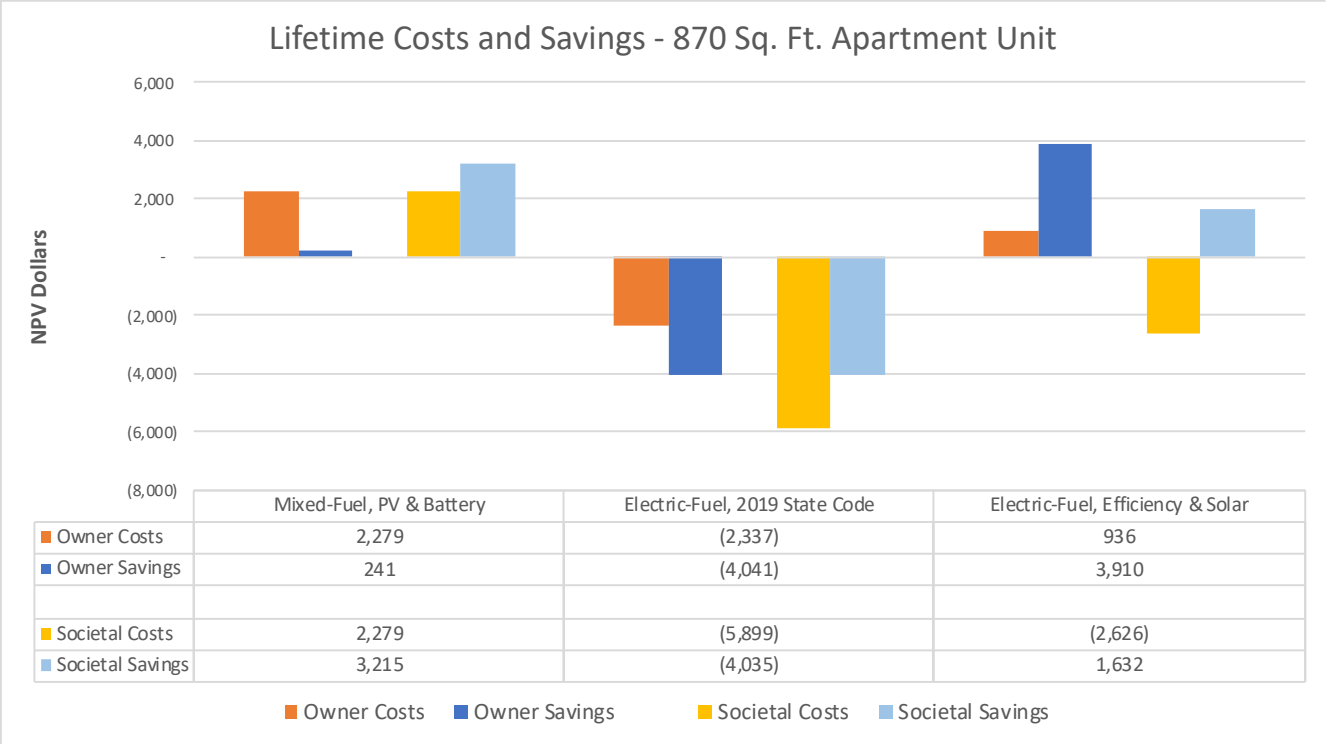


	Mixed-Fuel, PV & Battery	Electric-Fuel, 2019 State Code	Electric-Fuel, Efficiency & Solar
Owner Costs	5,438	(5,349)	3,169
Owner Savings	2,079	(9,779)	9,119
Societal Costs	5,438	(11,872)	(3,355)
Societal Savings	7,498	(7,766)	6,516

Figure 5: Costs and Benefits - Single-Family Home

	Climate Zone 3 PG&E Single Family		Annual Net kWh	Annual therms	EDR Margin[4]	PV Size Change (kW)[5]	CO2-Equivalent Emissions (lbs/sf)		NPV of Lifetime Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
							Total	Reduction		On-Bill	TDV
2	Mixed Fuel[1]	Code Compliant	(0)	348	n/a	n/a	1.88	n/a	n/a	n/a	n/a
3		Efficiency-Non-Preempted	(0)	296	2.5	(0.03)	1.63	0.26	$1,552	1.28	1.31
4		Efficiency-Equipment	(0)	273	4.0	(0.03)	1.52	0.37	$1,448	1.91	1.97
5		Efficiency & PV/Battery	(20)	296	10.0	0.07	1.50	0.38	$5,438	0.38	1.38
6	All-Electric[2]	Code Compliant	4,355	0	n/a	n/a	1.00	n/a	n/a	n/a	n/a
7		Efficiency-Non-Preempted	3,584	0	4.5	0.00	0.85	0.15	$1,519	2.60	2.36
8		Efficiency-Equipment	3,670	0	4.0	0.00	0.86	0.14	$2,108	1.76	1.62
9		Efficiency & PV	790	0	18.0	1.77	0.46	0.54	$8,517	2.22	1.68
10		Efficiency & PV/Battery	(12)	0	29.0	2.37	0.23	0.76	$14,380	1.50	1.58
11	Mixed Fuel to All-Electric[3]	Code Compliant	4,355	0	0.0	0.00	1.00	0.89	($5,349)	0.55	1.53
12		Efficiency & PV	790	0	18.0	1.77	0.46	1.43	$3,169	2.88	>1
13		Neutral Cost	2,217	0	10.5	1.35	0.70	1.18	$0	>1	>1

Figure 6: Benefit to Cost Ratios - Single-Family Home



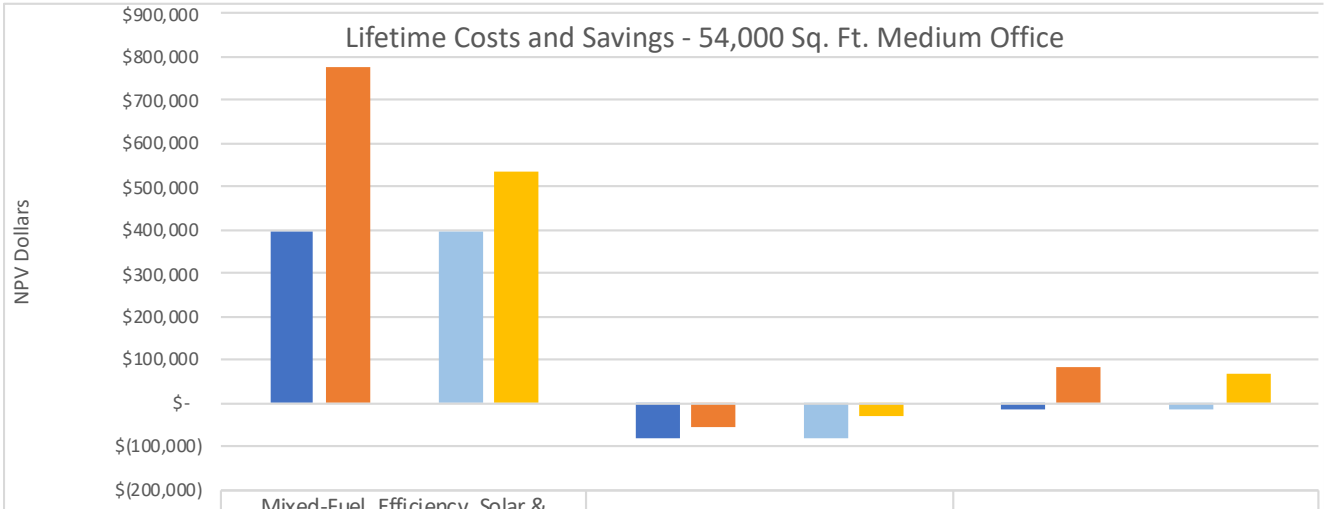
	Mixed-Fuel, PV & Battery	Electric-Fuel, 2019 State Code	Electric-Fuel, Efficiency & Solar
Owner Costs	2,279	(2,337)	936
Owner Savings	241	(4,041)	3,910
Societal Costs	2,279	(5,899)	(2,626)
Societal Savings	3,215	(4,035)	1,632

Figure 7 Costs and Benefits - Low-Rise Multifamily Unit

	Climate Zone 3 PG&E Multifamily		Annual Net kWh	Annual therms	EDR Margin[4]	PV Size Change (kW)[5]	CO2-Equivalent Emissions (lbs/sf)		NPV of Lifetime Incremental Cost ($)	Benefit to Cost Ratio (B/C)	
							Total	Reduction		On-Bill	TDV
2	Mixed Fuel[1]	Code Compliant	(0)	133	n/a	n/a	2.13	n/a	n/a	n/a	n/a
3		Efficiency-Non-Preempted	(0)	127	0.5	(0.00)	2.06	0.07	$175	1.00	1.11
4		Efficiency-Equipment	(0)	119	1.5	(0.00)	1.94	0.19	$403	1.11	1.23
5		Efficiency & PV/Battery	(10)	127	10.0	0.05	1.86	0.27	$2,279	0.11	1.41
6	All-Electric[2]	Code Compliant	1,944	0	n/a	n/a	1.27	n/a	n/a	n/a	n/a
7		Efficiency-Non-Preempted	1,944	0	0.0	0.00	1.27	0.00	$0	-	-
8		Efficiency-Equipment	1,698	0	2.5	0.00	1.13	0.14	$795	1.73	1.58
9		Efficiency & PV	457	0	16.0	0.92	0.69	0.58	$3,272	2.43	1.73
10		Efficiency & PV/Battery	(7)	0	29.5	1.26	0.33	0.94	$6,344	1.32	1.64
11	Mixed Fuel to All-Electric[3]	Code Compliant	1,944	0	0.0	0.00	1.27	0.86	($2,337)	0.58	1.46
12		Efficiency & PV	57	0	16.0	0.92	0.69	1.43	$936	4.18	>1
13		Neutral Cost	845	0	11.5	0.70	0.85	1.28	$0	>1	>1

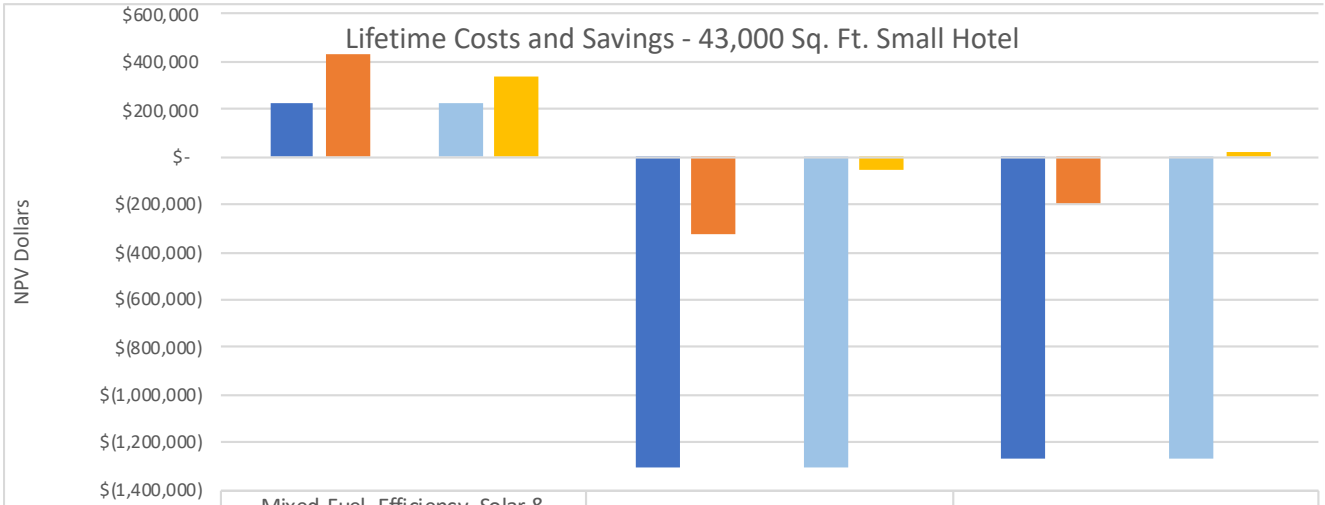
[1]All reductions and incremental costs relative to the **mixed fuel** code compliant home.
[2]All reductions and incremental costs relative to the **all-electric** code compliant home.
[3]All reductions and incremental costs relative to the **mixed fuel** code compliant home except the EDR Margins are relative to the Standard Design for each case which is the **all-electric** code compliant home. Incremental costs for these packages reflect the cots used in the On-Bill cost effectiveness methodology. Costs differ for the TDV methodology due to differences in the site gas infrastructure costs (see Section 2.6).
[4]This represents the Efficiency EDR Margin for the Efficiency-Non-Preempted and Efficiency-Equipment packages and Total EDR Margin for the Efficiency & PV, Efficiency & PV/Battery, and Neutral Cost packages.
[5]Positive values indicate an increase in PV capacity relative to the Standard Design.

Figure 8 Benefit to Cost Ratios - Low-Rise Multifamily Unit



	Mixed-Fuel, Efficiency, Solar & Battery	All-Electric, 2019 State Code	All-Electric, Energy Efficiency
Owner Costs	$397,405	$(82,330)	$(15,681)
Owner Savings	$777,156	$(57,345)	$85,241
Societal Costs	$397,405	$(82,330)	$(15,681)
Sociatel Savings	$536,330	$(29,592)	$68,682

Figure 9: Costs and Benefits - Medium Office



	Mixed-Fuel, Efficiency, Solar & Battery	All-Electric, 2019 State Code	All-Electric, Energy Efficiency
Owner Costs	$228,341	$(1,300,029)	$(1,267,509)
Owner Savings	$430,737	$(326,633)	$(198,234)
Societal Costs	$228,341	$(1,300,029)	$(1,267,509)
Sociatel Savings	$335,758	$(51,166)	$20,729

Figure 10: Costs and Benefits - Small Hotel