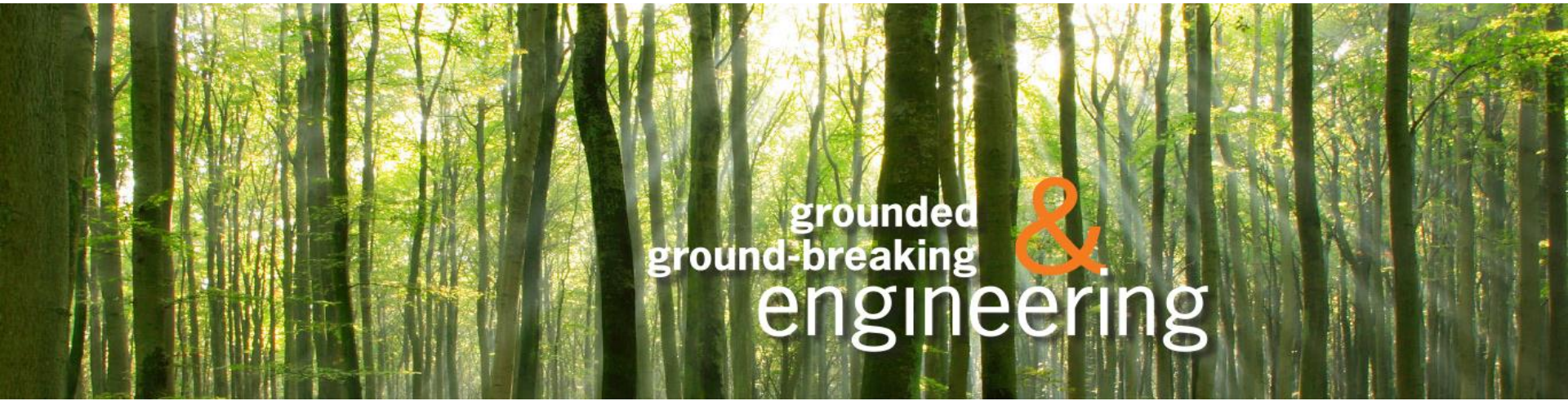
Reach Code Cost Effectiveness



Guttmann & Blaevoet
CONSULTING ENGINEERS

grounded
ground-breaking
&
engineering

Ted M. Tiffany

LEED AP BD&C
Principal
Director of Sustainability

CALIFORNIA'S 2019 RESIDENTIAL

BUILDING ENERGY EFFICIENCY STANDARDS

CALIFORNIA ENERGY COMMISSION

The state's energy efficiency standards for new buildings and appliances have saved consumers billions in lower electricity and natural gas bills. The 2019 Building Energy Efficiency Standards for residential buildings includes a first-in-the-nation requirement to install solar photovoltaic systems. Other features enable homes to reduce the electricity demand from the grid, helping to reduce energy bills and the carbon footprint.

$19,000 SAVINGS OVER A 30 YR. MORTGAGE | INITIAL COST $9,500

SOLAR PHOTOVOLTAIC SYSTEM

Promote installing solar photovoltaic systems in newly constructed residential buildings. The systems include smart inverters with optional battery storage. This will increase the self-utilization of the electricity generated to power the home's electricity loads including plug-in appliances. California is the first state in the nation to require smart systems on homes.

DEMAND RESPONSE COMPLIANCE OPTIONS

Encourage battery storage and heat pump water heaters that shift the energy use of the house from peak periods to off-peak periods. Utilities moving to time-of-use pricing assists the grid to meet the state's climate change goals and helps homes reduce energy bills.

HEALTHY INDOOR AIR QUALITY

Enable using highly efficient filters that trap hazardous particulates from both outdoor air and cooking and improve kitchen ventilation systems. Moving air around and in and out of the home while filtering out allergens and other particles makes the home healthier.

BUILDING ENVELOPE

Strengthen insulation in attics, walls and windows to improve comfort and energy savings. Keeping the heat out during the summer and warm air during the winter makes a home more resilient to climate change.

CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

Title 24, Parts 6 and 11
Local Energy Efficiency Ordinances

2019 Cost-effectiveness Study:
Low-Rise Residential New Construction

Table 1: Prototype Characteristics

Character	Single Family	Single Family	Multifamily
Conditioned Floor			
Num. of Stories			
Num. of Bedroom			
Window-to-Floor			

Source: 2019 Alternati

Table 2: Characteristics of the Mixed Fuel vs All-Electric Prototype

Characteristic	Mixed Fuel	All-Electric
Space Heating/Cooling[1]	Gas furnace 80 AFUE Split A/C 14 SEER, 11.7 EER	Split heat pump 8.2 HSPF, 14 SEER, 11.7 EER
Water Heater[1,2, 3, 4]	Gas tankless UEF = 0.81	50gal HPWH UEF = 2.0 SF: located in the garage MF CZ 2,4,6-16: located in living space MF CZ 1,3,5: located in exterior closet
Hot Water Distribution	Code minimum. All hot water lines insulated	Basic compact distribution credit, (CZ 6-8,15) Expanded compact distribution credit, compactness factor = 0.6 (CZ 1-5,9-14,16)
Drain Water Heat Recovery Efficiency	None	CZ 1: unequal flow to shower = 42% CZ 16: equal flow to shower & water heater = 65% None in other CZs
Cooking	Gas	Electric
Clothes Drying	Gas	Electric

Table 4: Incremental Cost Assumptions

Measure	Performance Level	Incremental Cost (2020 PV$)		Source & Notes
		Single Family	Multifamily (Per Dwelling Unit)	
Non-Preempted Measures				
Reduced Infiltration	3.0 vs 5.0 ACH50	$391	n/a	NREL's BEopt cost database ($0.115/ft² for 3 ACH50 & $0.207/ft² for 2 ACH50) + $100 HERS rater verification.
	2.0 vs 5.0 ACH50	$613	n/a	
Window U-factor	0.24 vs 0.30	$2,261	$607	$4.23/ft² window area based on analysis conducted for the 2019 and 2022 Title 24 cycles (Statewide CASE Team, 2018).
Window SHGC	0.50 vs 0.35	$0	$0	Data from CASE Report along with direct feedback from Statewide CASE Team that higher SHGC does not necessarily have any incremental cost (Statewide CASE Team, 2017d). Applies to CZ 1,3,5,16.
Cool Roof - Aged Solar Reflectance	0.25 vs 0.20	$237	$58	Costs based on 2016 Cost-effectiveness Study for Cool Roofs reach code analysis for 0.28 solar reflectance product. (Statewide Reach Codes Team, 2017b).
	0.20 vs 0.10	$0	$0	
Exterior Wall Insulation	R-7.5 vs R-5	$818	n/a	Based on increasing exterior insulation from 1" R-5 to 1.5" R-7.5 in a 2x6 wall (Statewide CASE Team, 2017c). Applies to single family only in all climates except CZ 6, 7.
Under-Deck Roof Insulation (HPA)	R-13 vs R-0	$1,338	$334	Costs for R-13 ($0.64/ft²), R-19 ($0.78/ft²) and R-30 ($1.61/ft²) based on data presented in the 2019 HPA CASE Report (Statewide CASE Team, 2017b) along with data collected directly from builders during the 2019 CASE process. The R-30 costs include additional labor costs for cabling. Costs for R-38 from NREL's BEopt cost database.
	R-19 vs R-13	$282	$70	
	R-30 vs R-19	$1,831	$457	
	R-38 vs R-30	$585	$146	
Attic Floor Insulation	R-38 vs R-30	$584	$146	NREL's BEopt cost database: $0.34/ft² ceiling area
Slab Edge Insulation	R-10 vs R-0	$553	$121	$4/linear foot of slab perimeter based on internet research. Assumes 16in depth.
	R-10 vs R-7	$157	$21	$1.58/linear foot of slab perimeter based on NREL's BEopt cost database. This applies to CZ 16 only where R-7 slab edge insulation is required prescriptively. Assumes 16in depth.
Duct Location	<12 feet in attic	$358	n/a	Costs based on a 2015 report on the Evaluation of Ducts in Conditioned Space for New California Homes (Davis Energy Group, 2015). HERS verification cost of $100 for the Verified Low Leakage Ducts in Conditioned Space credit.
	Ducts in Conditioned Space	$658	n/a	
	Verified Low Leakage Ducts in Conditioned Space	$768	$110	

Table 4: Incremental Cost Assumptions

Measure	Performance Level	Incremental Cost (2020 PV$)		Source & Notes
		Single Family	Multifamily (Per Dwelling Unit)	
Heat Pump SEER/EER /HSPF	16/13/9 vs 14/11.7/8.2	$411	$411	Costs from online retailers for 2-ton unit. Replacement at year 15 assumes a 50% reduction in first cost.
	18/14/10 vs 14/11.7/8.2	$1,511	$1,511	
Tankless Water Heater Energy Factor	0.96 vs 0.81	$203	$203	Equipment costs from online retailers for 40-kBtu/h unit. Cost saving for 6-feet of venting at $26/foot due to lower cost venting requirements for condensing (PVC) vs non-condensing (stainless) furnaces. Replacement at year 15 assumes a 50% reduction in first cost.
HPWH	NEEA Tier 3 vs 2.0 EF	$294	$294	Equipment costs from online retailers. Replacement at year 15 assumes a 50% reduction in first cost.
PV + Battery				
PV System	System size varies	$3.72/W-DC	$3.17/W-DC	First costs are from LBNL's Tracking the Sun 2018 costs (Barbose et al., 2018) and represent costs for the first half of 2018 of $3.50/W-DC for residential system and $2.90/W-DC for non-residential system ≤500 kW-DC. These costs were reduced by 16% for the solar investment tax credit, which is the average credit over years 2020-2022. Inverter replacement cost of $0.14/W-DC present value includes replacements at year 11 at $0.15/W-DC (nominal) and at year 21 at $0.12/W-DC (nominal) per the 2019 PV CASE Report (California Energy Commission, 2017). System maintenance costs of $0.31/W-DC present value assume $0.02/W-DC (nominal) annually per the 2019 PV CASE Report (California Energy Commission, 2017). 10% overhead and profit added to all costs
Battery	System size varies by building type	$656/kWh	$656/kWh	$633/kWh first cost based on the PV Plus Battery Study report (Statewide Reach Codes Team, 2018) as the average cost of the three systems that were analyzed. This cost was reduced by 16% for the solar investment tax credit, which is the average credit over years 2020-2022. Replacement cost at year 15 of $100/kWh based on target price reductions (Penn, 2018).

Table 6: Incremental Costs – All-Electric Code Compliant Home Compared to a Mixed Fuel Code Compliant Home

Measure	Incremental Cost (2020 PV$) Single Family[1]				Incremental Cost (2020 PV$) Multifamily[1] (Per Dwelling Unit)			
	Low	High	Typical (On-Bill)	Typical (TDV)	Low	High	Typical (On-Bill)	Typical (TDV)
Heat Pump vs Gas Furnace/Split AC	($2,770)	$620	($221)		Same as Single Family			
Heat Pump Water Heater vs Gas Tankless	($1,120)	$1,120	$0					
Electric vs Gas Clothes Dryer[2]	($428)	$820	$0					
Electric vs Gas Cooking[2]	$0	$1,800	$0					
Electric Service Upgrade	$200	$800	$600		$150	$600	$600	
In-House Gas Infrastructure	($1,670)	($550)	($800)		($600)	($150)	($600)	
Site Gas Infrastructure	($25,000)	($900)	($5,750)	($11,836)	($16,250)	($310)	($3,140)	($6,463)
Total First Cost	***($30,788)***	***$3,710***	***($6,171)***	***($12,257)***	***($20,918)***	***$4,500***	***($3,361)***	***($6,684)***
Present Value of Equipment Replacement Cost			***$1,266***				***$1,266***	
Lifetime Cost Including Replacement & Financing of First Cost			***($5,349)***	***($11,872)***			***($2,337)***	***($5,899)***

[1]Low and high costs represent the potential range of costs and typical represents the costs used in this analysis and determined to be most representative of the conditions described in this report. Two sets of typical costs are presented, one which is applied in the On-Bill cost effectiveness methodology and another applied in the TDV methodology.

[2]Typical costs assume electric resistance technology. The high range represents higher end induction cooktops and heat pump clothes dryers. Lower cost induction cooktops are available.

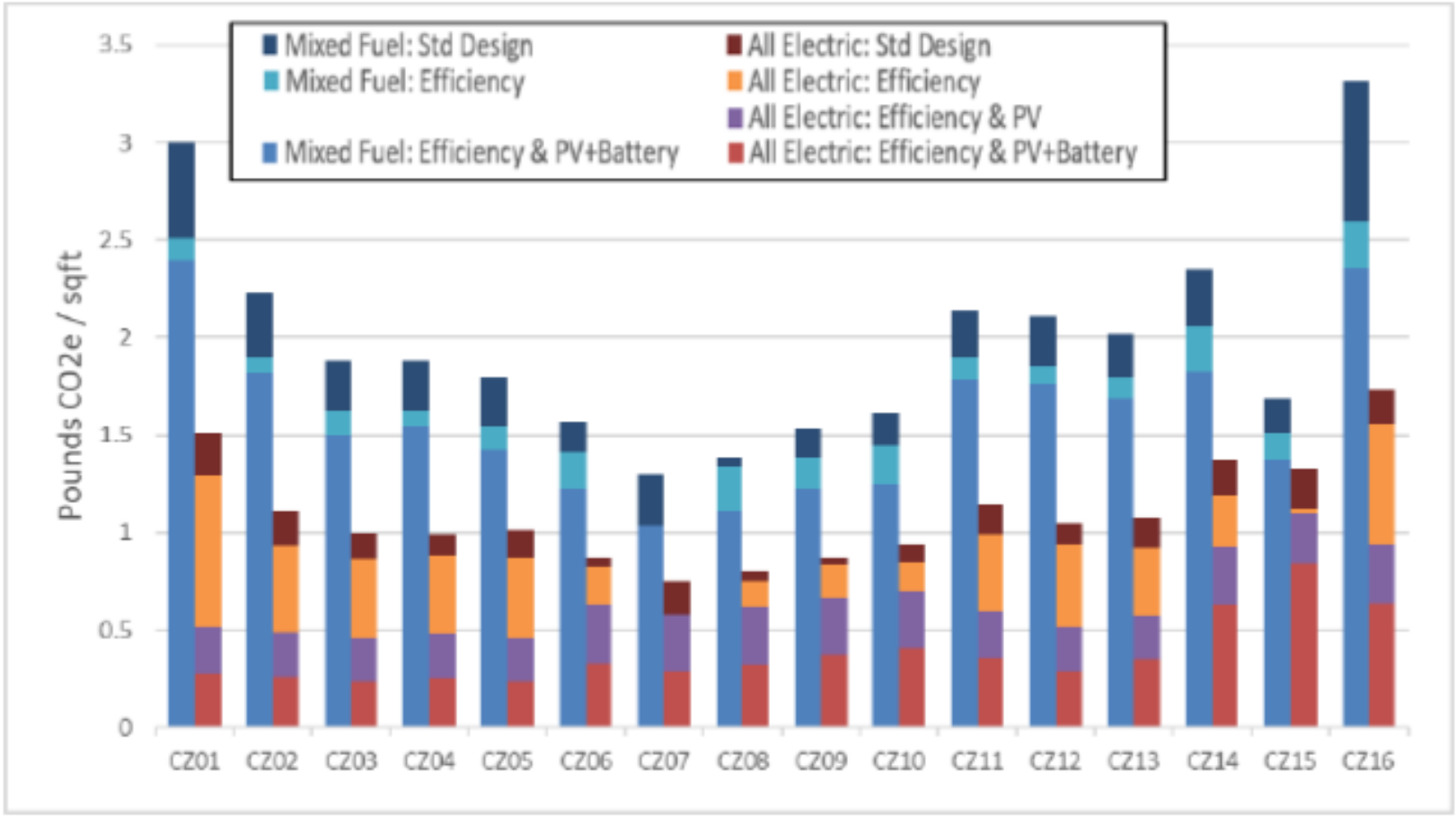


Figure 5: Single family greenhouse gas emissions comparison

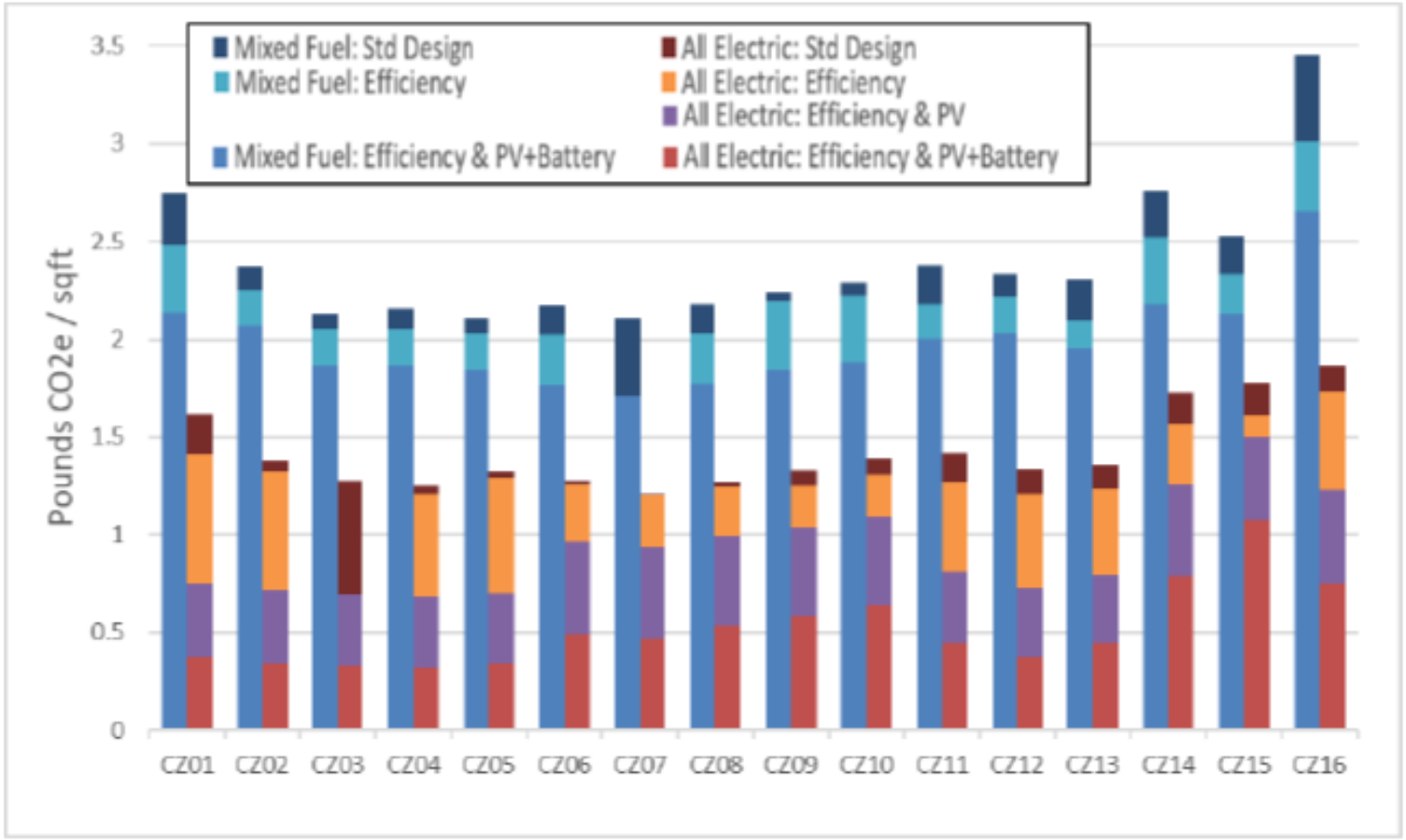


Figure 8: Multifamily greenhouse gas emissions comparison

Table 2: Single Family City of Healdsburg Climate Zone 2 Results Summary

Climate Zone 2 Healdsburg/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
Mixed Fuel[1]	Code Compliant	(0)	421	n/a	n/a	2.23	n/a	n/a	n/a	n/a
	Efficiency-Non-Preempted	0	360	3.0	(0.04)	1.94	0.30	$1,504	1.60	1.66
	Efficiency-Equipment	(0)	352	3.0	(0.03)	1.90	0.33	$724	3.73	3.63
	Efficiency & PV/Battery	(22)	360	10.0	0.06	1.82	0.41	$5,393	0.62	1.56
All-Electric[2]	Code Compliant	5,014	0	n/a	n/a	1.11	n/a	n/a	n/a	n/a
	Efficiency-Non-Preempted	4,079	0	4.5	0.00	0.94	0.18	$3,943	0.90	1.07
	Efficiency-Equipment	4,122	0	5.0	0.00	0.94	0.17	$2,108	1.65	2.10
	Efficiency & PV	847	0	19.0	2.07	0.49	0.63	$12,106	1.57	1.38
	Efficiency & PV/Battery	(15)	0	30.0	2.71	0.26	0.86	$18,132	1.33	1.43
Mixed Fuel to All-Electric[3]	Code Compliant	5,014	0	0.0	0.00	1.11	1.12	($5,349)	0.91	1.59
	Efficiency & PV	847	0	19.0	2.07	0.49	1.75	$6,758	1.94	39.70
	Neutral Cost	2,891	0	9.5	1.36	0.82	1.41	$0	236.64	>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.

Table 3: Multifamily City of Healdsburg Climate Zone 2 Results Summary – Results per Unit

Climate Zone 2 Healdsburg/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
Mixed Fuel[1]	Code Compliant	(0)	150	n/a	n/a	2.37	n/a	n/a	n/a	n/a
	Efficiency-Non-Preempted	0	142	1.5	(0.02)	2.25	0.12	$309	0.90	1.75
	Efficiency-Equipment	(0)	134	2.0	(0.01)	2.15	0.22	$497	1.05	1.49
	Efficiency & PV/Battery	(11)	142	10.5	0.04	2.07	0.30	$2,413	0.35	1.60
All-Electric[2]	Code Compliant	2,151	0	n/a	n/a	1.38	n/a	n/a	n/a	n/a
	Efficiency-Non-Preempted	2,038	0	1.5	0.00	1.32	0.06	$361	1.27	2.05
	Efficiency-Equipment	1,928	0	3.0	0.00	1.25	0.13	$795	1.11	1.56
	Efficiency & PV	476	0	17.5	1.00	0.72	0.67	$3,711	2.13	1.82
	Efficiency & PV/Battery	(7)	0	30.5	1.36	0.35	1.04	$6,833	1.59	1.74
Mixed Fuel to All-Electric[3]	Code Compliant	2,151	0	0.0	0.00	1.38	0.99	($2,337)	0.55	1.42
	Efficiency & PV	60	0	17.5	1.00	0.72	1.65	$1,375	2.69	>1
	Neutral Cost	1,063	0	10.5	0.70	0.96	1.41	$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.

MITHŪN

105 units of Multifamily Type IIIA over Type IA Building:

Cost Comparison

	All Electric		Natural Gas	
DHW	Colmac HPHW	$ 106,820	Boiler RayPack	$ 30,580
	Tanks	$ 29,131	Tanks	$ 14,900
	Add Labor/HR	$ 14,104		
Solar HW	None	$ -	40% Fraction	$ 219,000
ReCirc	same	$ -	same	$ -
Bldg	NA	$ -	Gas Trench, backfill, pipe, stubout inside	$ 25,000
	NA	$ -	flextend joints	$ 10,000
	NA	$ -	Gas Meter Room	$ 28,550
	NA	$ -	Gas piping to Boiler Room	$ 11,904
	NA	$ -	Insulated copper pipe to Solar Thermal to Tanks	$ 25,000
	NA	$ -	Gas to Laundry	$ 9,933
	NA	$ -	Gas Ventilation	$ 8,000
Utility Connection	Gas Connection	$ -	Gas Connection	$ 15,000
TOTAL		**$ 150,055**		**$ 397,867**
Solar PV	*Array 123,000kW*	*$ 443,566*	*assume half*	*$ 221,500*
TOTAL w PV		*$ 593,621*		*$ 619,367*

Summaries

Electric DWH	$ 150,055	
Gas DHW	$ 45,480	$ 104,575
GasBldg Costs	$ 133,387	
Total Diff:	**$ 247,812**	
Total Diff:	**$ 25,746**	

Notes

*All estimates provided by subs in Aug 2019 unless noted otherwise

Gas Boilers are less expensive; less storage req'd.

Estimate by subs in Feb 2019

Estimate by owners' rep; awaiting verification from recent projects. Appx between $40k - $100k.

Electric building systems are between $250k-$300k less, if the Gas option includes Solar Therma DHW;

Estimate by subs in May 2019

CASE STUDY
ECOTOPE "RCC"
SYSTEM-194 UNIT

ECOTOPE.COM

MARKET DEVELOPMENT NEEDS

ECOTOPE.COM

DESIGN TOOLS

- ❑ Circulation loop losses and reheat sizing
- ❑ Primary plant sizing (capacity & storage) optimization
- ❑ Simulation Protocol

BUILDING DECARBONIZATION COALITION

CALIFORNIA ENERGY COMMISSION

Redwood Energy
Foremost Zero Net Energy Specialists in Multifamily Housing

Guttmann & Blaevoet CONSULTING ENGINEERS

ECOTOPE

Napa Creek Village, Napa, CA

Napa Creek Village, developed by Thriving Communities with Redwood Energy's support, offers a mix of hig end and workforce townhomes for – with a 100% solar PV offset paired with battery storage. The design of Napa creek includes high standards green building materials, off site me framed panelized construction that be assembled on site. In addition, th development will include grey wate recycling, LED lighting, passive heat and cooling with an HRV, optimizati of building orientation, living walls a tight building envelope, recycled ste framing (recycles 6 cars per unit), electric car charging stations, and edible community gardens. It also features a rent to own program alo

The Eureka Homeless and Veterans Housing, Eureka, CA

This project is being built by Danco Communities in Eureka, California with Redwood Energy's support with 50 one-bedroom, 550 sf residences. The 100% solar offset apartments were built for $315,000/unit, at a cost of $572/square foot and a density of 84 units/acre. To lower costs by $3000/apt and maintain high efficiency, an 80 gallon heat pump tank run at 135F is shared among four to five apartments, rather than one smaller tank per apartment. To save $4000 per apartment the apartments use electric resistance wall heaters and Energy Recovery Ventilators (ERVs) instead of heat pumps—the cool summers in Eureka, just five blocks from the Humboldt Bay, rarely call for air conditioning.

Illustrated Design Principle: From the lessons learned at Colonial House - electric resistance heating and ceiling fans can achieve an energy efficient and comfortable design.

HVAC	Electric resistance heating, no cooling
DHW	Mini plant, 1 80 gal per four apartments
Cooking	Radiant Glass Top
Envelope	Energy Star equivalent

Redwood Energy

Foremost Zero Net Energy Specialists in Multifamily Housing

https://fossilfreebuildings.org/ElectricMFGuide.pdf

UC Santa Cruz
Student Housing West
Capstone

UC Riverside
Dundee Residence Hall
American Campus Communities

UC Irvine
Student Housing West
American Campus Communities

UC Davis
Student Housing
DPR GC

Station House
Oakland, CA
City Venture

Ice House
Oakland, CA
City Venture

52 Shell, S. (2019). Multi-Family Building Electrification Current Examples. EHDD Architecture.

https://fossilfreebuildings.org/ElectricMFGuide.pdf

Commercial Ovens (208V)

Make/Model	Bakers Pride BCO-E1	Vulcan VC5ED-11D1	Blodgett BDO-100-E
			
Price	$3,324		
Kilowatts	10.5kW		

Commercial Single Burner Counterto

Make/Model	Update International IC
	
Price	$200
Temp. Range	140°F-460°F

Electric Induction Woks (240V / 1

Make/Model	Spring SM-351WCR-8
	
Price	$1,470
kW	3.5

	Blower	Chain Saw	Po
STIHL[81]	BGA 100 ($350) 	MSA 160 C-BQ ($350) 	
Husqvarna[82]	550iBTX ($500) 	T536Li XP ($400) 	
RYOBI[83]	RY40440 ($270) 	P549 ($200) 	

*Prices will vary – visit retailers for the most current co

Indoor Electric Fireplaces

	ClassicFlame Felicity	Amantii Zero Clearance	Modern Flames CLX Series
			
Size	46.6"W, 19.75"H,5"D	29.5"W, 38.75"H, 8.5" D	144" W,25.5" H, 5.3" D
Price	$350	$1,300	$7,500
Voltage/Amps	120V/12.5A	120V/12.5A	120V
Heat Output	1,500W	1,500W	1,500W

	Dimplex Opti-Myst Pro 1000	Napoleon See-thru	Dynasty DY-BT79
			
Size	40.1" W, 9.5"H, 12" D	50"W, 18.4"H, 9"D	80"W, 19.3" H, 7" D
Price	$2100	$2,000	$1,300
Voltage/Amps	120V	120V/240V	120V/10.8A
Heat Output	460W	3,000W	1,300W

Outdoor Electric Fireplaces/Heaters

	Dimplex Opti-Myst Pro 500	Touchstone Sideline	EnerG+ Patio Heater
			
Size	20" W, 9.5"H, 12" D	50"W,17.9"H ,6"D	11" W, 4'3"H,11"D
Price	$1300	$574	$186.99
Voltage/Amps	120V/3.83A	120V/11A	110V/13A
Heat Output	230W	1,500W	1,500W

Redwood Energy

Foremost Zero Net Energy Specialists in Multifamily Housing

https://fossilfreebuildings.org/ElectricMFGuide.pdf

Goldman School of Public Policy New Classroom Building and Hearst Avenue Housing & Garage

- All-electric design
- Rooftop Heat Pump for HHW
- Low Temp DX Cooling Rooftop Unit
- Smart VAV diffusers
- Electric Radiant Heat with ERV for Residential
- Estimated completion 2021

Goldman School of Public Policy New Classroom Building and Hearst Avenue Housing & Garage

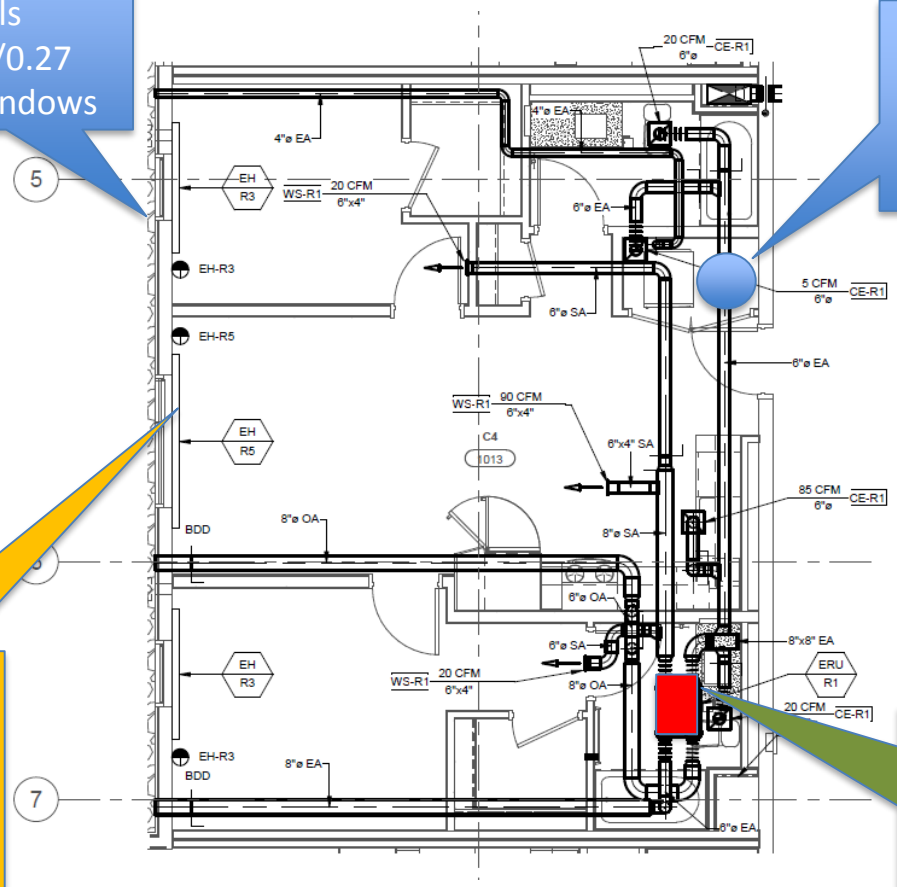
- Simplified Construction
- Lowered First Cost
- Allowed for individually metered apartments
- NO central systems for residences to maintain

R-21 + R-10 Rigid Wood Framed Walls U-0.26/0.27 SHGC Windows

Heat Pump Water Heater Co-located with Washer/Dryer

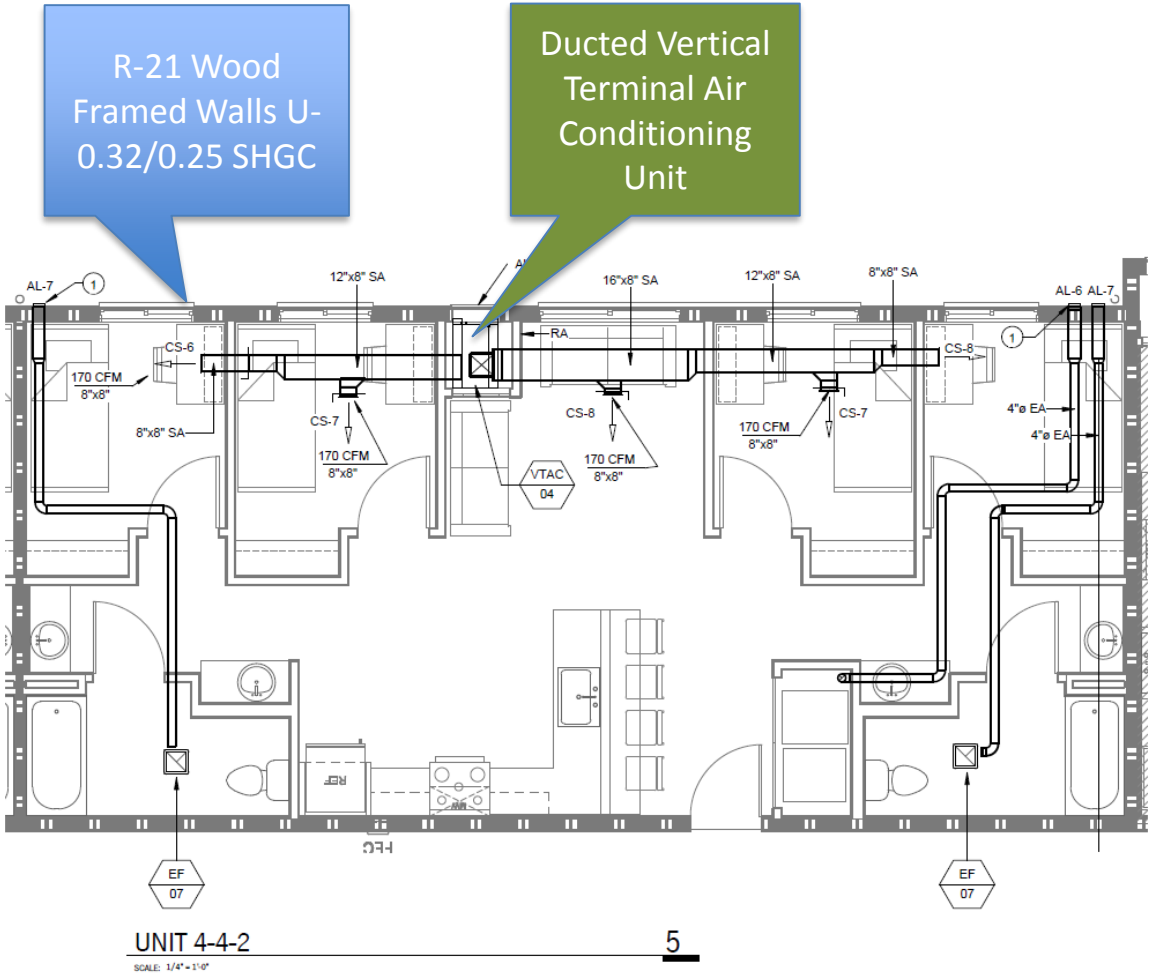
< 3kW (2.8kW) TOTAL of electric resistance heating for largest Apartment

Energy Recovery Ventilator 69% Sensible Heat Recovery Effectiveness



Sacramento State P3 Housing

- 8 Buildings, 1100 Beds
- Vertical Heat Pumps
- All Electric Kitchens
- On-site Carport plus Rooftop solar PV
- HEAT PUMP Central Boilers VALUE ENGINEERED TO BOILERS
- Estimated completion 2021



Sacramento State P3 Housing

- Required to be heated and cooled
- More dense occupancy than normal dorms increased both DHW load and competition for space, full sized washers used instead of stacked competing for space
- Central Boilers selected over central heat pump system because extra building to house heat pump and storage tanks added significant costs. Rooftop was dedicated to PV arrays and developer wanted limited equipment on the roof
- Developers were also concerned about maintenance costs for Central Heat pumps and having to educate staff on new technology.

Santa Rosa Junior College: Burbank Theater and Geothermal Plant

- Geothermal field connecting 6 existing buildings
- Heat recovery (6-pipe) chiller
- Eliminate gas boilers and water heaters.
- Building ZNE Retrofit – envelope and MEP systems
- Chilled and hot water air handlers
- Displacement ventilation in auditoriums.
- Estimated completion 2019

Santa Rosa Junior College: Burbank Theater and Geothermal Plant

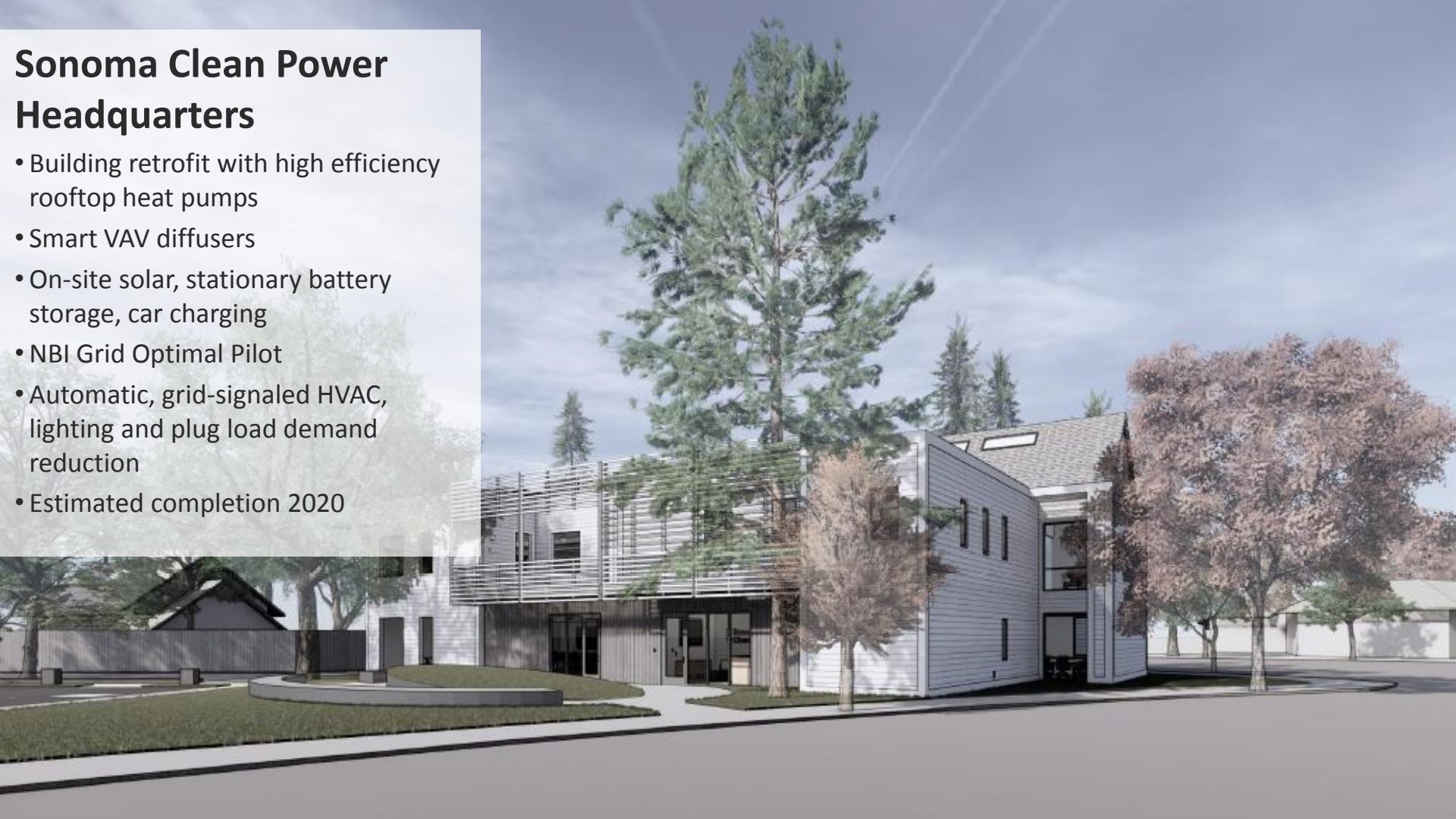
- Analysis for performance of underutilized existing field to connect additional buildings to
- Creating new geothermal field under the existing track and football field and under renovated parking lot.
- Enhanced SRJC's goals to go All-Electric and enhance microgrid and renewable energy projects.
- Eliminated the need to rebuild failed Co-Gen plant

Albany High School

- All-electric, ZNE Design
- Daylighting Analysis
- Single Zone VAV Heat Pumps
- Heat Recovery Ventilators
- Heat Pump Water Heaters
- Mixed Mode Design with window sensors
- 80 kW of PV
- Estimated completion 2019

Sonoma Clean Power Headquarters

- Building retrofit with high efficiency rooftop heat pumps
- Smart VAV diffusers
- On-site solar, stationary battery storage, car charging
- NBI Grid Optimal Pilot
- Automatic, grid-signaled HVAC, lighting and plug load demand reduction
- Estimated completion 2020



Sonoma Clean Power Headquarters

- Building retrofit with high efficiency rooftop heat pumps
- Smart VAV diffusers
- On-site solar, stationary battery storage, car charging
- NBI Grid Optimal Pilot
- Automatic, grid-signaled HVAC, lighting and plug load demand reduction
- Estimated completion 2020

Winter Warm Up Carbon Peaking

						ECM-5	150 kWh Battery	400kWh Battery	600 kWh Battery
1/1/2019 22:00	3.9	5.3	5.3	4.8	5.3	4.8	2.0	2.0	2.0
1/1/2019 23:00	16.5	12.3	12.3	10.5	12.3	10.5	13.2	2.3	2.3

Summer Afternoon Carbon Peaking

							150 kWh Battery	400kWh Battery	600 kWh Battery
8/7/2019 0:00	2.9	0.7	0.7	0.7	0.7	0.7	9.2	9.2	9.2
8/7/2019 1:00	0.7	0.7	0.7	0.7	0.7	0.7	8.6	8.6	8.6
8/7/2019 2:00	0.7	0.7	0.7	0.7	0.7	0.7	8.5	8.5	8.5
8/7/2019 3:00	0.7	0.7	0.7	0.7	0.7	0.7	8.6	8.6	8.6
8/7/2019 4:00	1.3	1.3	1.3	1.3	1.3	1.3	7.4	9.0	9.0
8/7/2019 5:00	8.7	8.6	8.7	7.8	8.6	7.3	7.3	9.3	9.3
8/7/2019 6:00	10.8	10.9	10.8	9.4	10.9	9.5	9.5	9.6	9.6
8/7/2019 7:00	14.5	15.4	14.5	14.6	15.4	15.4	9.7	9.7	9.7
8/7/2019 8:00	11.7	12.3	11.6	11.7	12.3	12.5	8.8	8.8	8.8
8/7/2019 9:00	13.9	14.8	13.9	13.0	14.8	13.7	8.5	8.5	8.5
8/7/2019 10:00	16.5	17.2	16.4	14.3	17.2	14.8	8.8	8.8	8.8
8/7/2019 11:00	16.0	16.6	15.9	13.6	16.6	14.2	8.9	8.9	8.9
8/7/2019 12:00	19.0	19.6	17.5	16.4	19.6	16.0	9.5	9.5	9.5
8/7/2019 13:00	22.1	9.9	20.5	19.7	9.9	11.2	9.8	9.8	9.8
8/7/2019 14:00	25.1	22.7	22.3	21.4	22.7	18.2	10.6	10.6	10.6
8/7/2019 15:00	29.5	24.5	24.0	23.0	24.5	21.0	11.5	11.5	11.5
8/7/2019 16:00	19.1	25.7	25.0	24.0	25.7	20.3	11.9	11.9	11.9
8/7/2019 17:00	19.3	25.1	26.2	25.2	25.1	19.5	12.9	12.4	12.4
8/7/2019 18:00	22.8	27.7	27.8	26.6	27.7	23.4	22.8	13.3	13.3
8/7/2019 19:00	25.1	22.8	29.1	26.0	22.8	19.2	18.6	13.6	13.6
8/7/2019 20:00	17.4	14.5	20.9	16.5	14.5	12.6	13.4	13.4	13.4
8/7/2019 21:00	9.1	1.9	1.9	1.9	1.9	1.9	12.9	12.9	12.9
8/7/2019 22:00	7.5	0.9	0.9	0.9	0.9	0.9	11.7	11.7	11.7

Alexander Valley Medical Center

- 48,000 sf OSHPD 3 Clinic
- Heat Recovery Ventilators (DOAS) to provide Table 3 ACH and Filtration.
- VRF FC's to provide temperature control
- On-site Carport plus Rooftop solar PV
- Estimated completion 2021

Questions?

THANK YOU!

grounded
ground-breaking
&
engineering

Ted M. Tiffany
LEED AP BD&C
Principal
Director of Sustainability