

ELECTRIFICATION OF MULTIFAMILY HOUSING

By SEAN ARMSTRONG of
REDWOOD ENERGY



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REDWOOD ENERGY: SEAN ARMSTRONG AND MICHAEL WINKLER

- Sean and Michael separately began working on off-grid, solar powered houses in 1996
- Sean: B.S. in Natural Resources Conservation, Science teacher ('02-05) and Project Manager ('05-'11) for large developer/GC
- Michael: B.S. degrees in Physics and Engineering, career in telecommunications, then as a renewable energy/fuel cell researcher with the Schatz Lab. Twice elected Mayor of Arcata



ELECTRIC HEATING TARIFF



**Pacific Gas and
Electric Company**

U 39

San Francisco, California

Cancelling Revised
Revised

Cal. P.U.C. Sheet No. 34229-E
Cal. P.U.C. Sheet No. 30408-E

ELECTRIC SCHEDULE E-1 RESIDENTIAL SERVICES

Sheet 3

**SPECIAL
CONDITIONS:**

1. **BASELINE RATES:** PG&E may require the customer to complete and file with it a Declaration of Eligibility for Baseline Quantities for Residential Rates.
2. **BASELINE (TIER 1):** The following quantities of electricity are to be billed at the rates for baseline use:

BASELINE QUANTITIES (kWh PER DAY)

Baseline Territory*	Code B - Basic Quantities				Code H - All-Electric Quantities			
	Summer		Winter		Summer		Winter	
	Tier I		Tier I		Tier I		Tier I	
P	13.8	(C)	12.3	(C)	16.4	(C)	29.6	(C)
Q	7.0		12.3		8.3		29.6	
R	15.6		11.0		18.8		29.8	
S	13.8		11.2		16.4		27.1	
T	7.0		8.5		8.3		14.9	
V	8.7		10.6		13.6		26.6	
W	16.8		10.1		20.8		20.6	
X	10.1		10.9		9.3		16.7	
Y	10.6		12.6		13.0		27.1	
Z	6.2	(C)	9.0	(C)	7.7	(C)	18.7	(C)

ELECTRIC HEATING TARIFF



**Pacific Gas and
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San Francisco, California

Cancelled

Revised
Revised

Cal. P.U.C. Sheet No.
Cal. P.U.C. Sheet No.

19910-E
19771-E

ELECTRIC SCHEDULE E-1 RESIDENTIAL SERVICES

Sheet 4

SPECIAL
CONDITIONS:
(Cont'd.)

3. ANNUAL CONTRACT: For customers who use service for only part of the year, this schedule is applicable only on an annual contract.
4. ALL-ELECTRIC QUANTITIES (Code H): All-electric quantities are applicable to service to customers with permanently installed electric heating as the primary heat source. All-electric quantities are also applicable to service to customers of record as of November 15, 1984, to whom the former Code W (Basic plus Water Heating) lifeline allowance was applicable on May 15, 1984, and who thereafter maintain continuous service at the same location under this schedule.

If more than one electric meter serves a residential dwelling unit, the all-electric quantities, if applicable, will be allocated only to the primary meter.

(L)

TDV SETTING FOR ELECTRIC HEATING

Project Design Data | Project Title | Designer | Lighting | Mechanical | Forms | Residential | Res Lighting | Utility | Outdoor

General

Building Name: Creamery Row Townhomes

Building Type: New

Job No:

Front Orientation: 196

Rotation: 16

Location

Country: UNITED STATES

State: California


City: Arcata

Zone: 01

User Defined

Principal Heating Source

Natural Gas
 Propane
 Electric (Natural Gas Available)
 Electric (No Natural Gas Available)



Res T24 Performance

Calculation	*Heating	*Cooling	Int	Ext	Appliances	Receptacles	*IAQ	*Renewable	*DHW	Total	Savings
Standard	29.99	0.00	11.83	0.94	33.33	26.50	2.98	0.00	26.80	132...	0.0 %
Proposed	25.89	0.02	11.83	0.94	33.33	26.50	2.98	0.00	16.27	117...	24.4 %

BUILDING OFFICIALS' ROLE IN TDV SETTING



CITY of NAPA

www.cityofnapa.org

COMMUNITY DEVELOPMENT DEPARTMENT
BUILDING DIVISION
1600 First Street
Mailing Address:
P.O. Box 660
Napa, California 94559-0660
Phone: 707-257-9540
Fax: 707-257-9522
TTY: (707) 257-9506

December 22, 2016

Re: Napa Creek Village

To Whom It May Concern:

The Napa Creek Village project constructed by Thriving Communities at 2614 First Street Napa was plan reviewed and permitted by the City of Napa Building Department per Plan Check Resubmittal #3 dated March 23, 2016. The project does not have gas service lines to the property even though it is in PG&E gas territory. The building department has reviewed and approved the project's building plans, which includes the energy model(s) that indicates there is no gas available and is aware of the implications this has for California Title 24, part 6 compliance.

Sincerely,

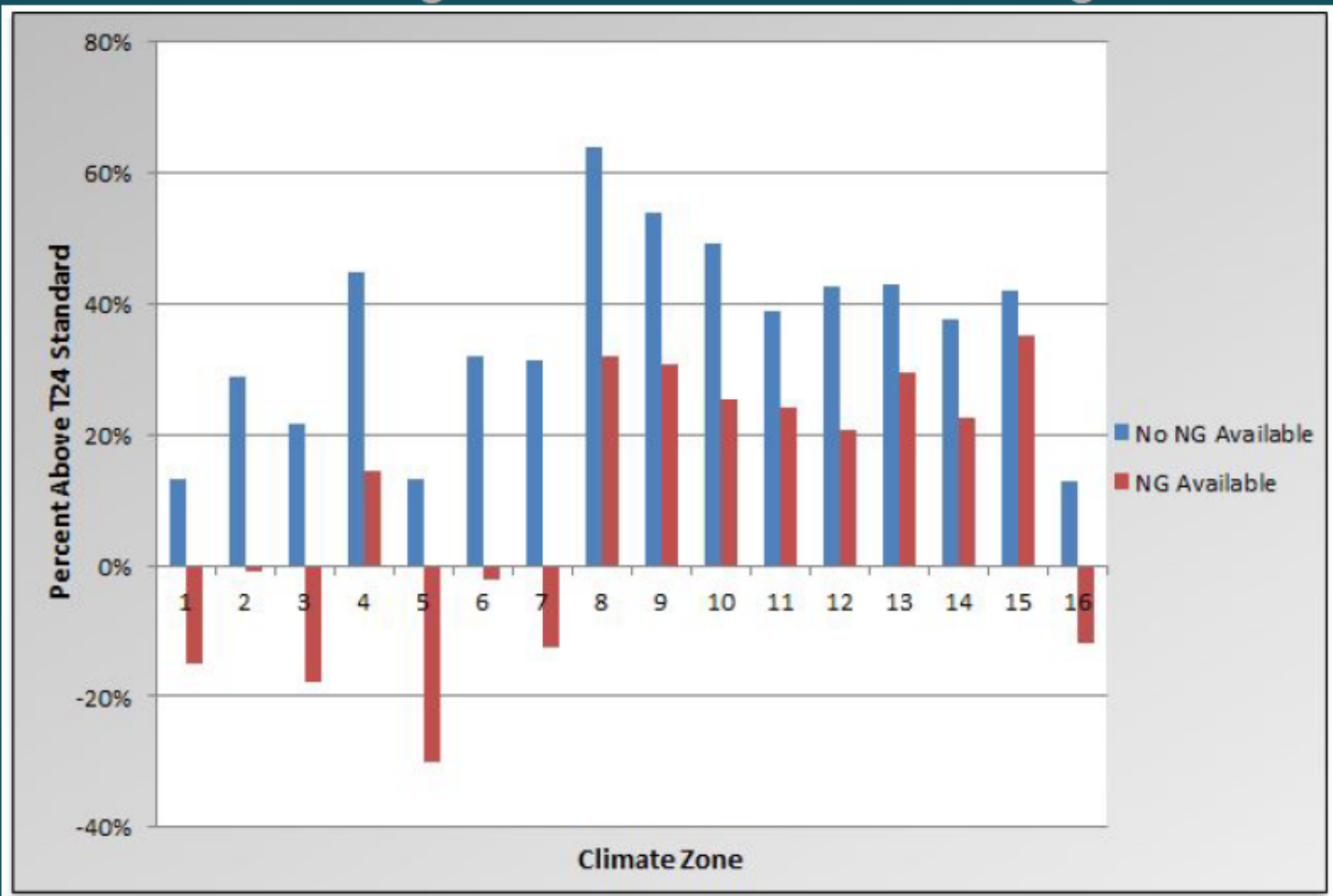


Dan Kavarian
Chief Building Official
City of Napa

IMPACT OF TDV SETTING ON AN ALL-ELECTRIC ENERGY STAR HOME

All Electric Home Gas Available vs No Gas Available Percentage above T24 Standard design

2016 code compliance
Software results



COMPARISON OF COMPLIANCE SETTINGS IN PALO ALTO

Name of the Palo Alto/TRC Energy Models	% Compliance: Natural Gas Available for Space Heating	% Compliance: Natural Gas <u>Not</u> Available for Space Heating
2100ft2_HPTU50_Goodman_8.5	7	30
2100ft2_HPTU66_Goodman_8.5	11	33
2700ft2_HPTU50_Goodman_8.5_z2	6	27
2700ft2_HPTU66_Goodman_8.5_z2	10	30
2100 Alt Electrification_HPTU50_HPSH	-6	15
2700 Alt Electrification_HPTU50_HPSH_2z	-5	14
2100ft2_HPSH_Goodman_8.5	6	5
2700ft2_HPSH_Goodman_8.5_z2	6	5
2100 Alt_Goodman 8.5 HPSH	-6	1
2700 Alt_Goodman 8.5 HPSH	-4	2
6960LRM Alt Electrification_HPTU50_HPSH	-11.5	16.8
6960LRM Alt Electrification_Goodman 8.5 HPSH_sr	-6.9	-4.8

ALL-ELECTRIC CONSTRUCTION IS CHEAPER



California's Next Frontier: Clean Electricity for Everything

Posted: 24 May 2016 11:46 AM PDT

By David Hochschild and Mark Ferron

Electrification can also reduce costs. California home builders such as City Ventures and KB Homes have begun building homes without gas lines, where gas central heating, hot water and stoves are replaced by electric appliances. By avoiding the need to install gas pipelines under the streets and inside homes, these forward-thinking builders are able to reduce the price of the home by \$4,500.

RHEEM: HEAT PUMPS ARE CHEAPER THAN FURNACES



Rheem 3 Ton 14 SEER Heat Pump Split System R410A Refrigerant

from ACWholesalers.com

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Overview for Rheem RH1T3617STANJA RP1436AJ1NAThis Rheem 3 Ton 14 SEER Heat Pump Split System Bundle comes with a highly featured and reliable Rheem RP1436AJ1NA heat pump ...

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\$2,085.38

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★★★★★ (3,949)



Rheem 3 Ton 14 SEER 80% AFUE 75K BTU R410A Complete Split System AC and Gas

from Ingrams Water And Air Equipment

Rheem

Condenser Model: RA1436AJ1NA Coil Model: RCF3617STAMCA Furnace Model: R801SA075417MSA Rheem 3 Ton 14 SEER 80% AFUE 75K BTU R410A Complete Split System AC and Gas Rheem RA14 3 ...

[See more details at Ingrams Water And Air Equipment](http://Ingrams Water And Air Equipment) »

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Ingrams Water And Air Equipment

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FOR BOTH CENTRAL AND INDIVIDUAL DHW, EFFICIENT HEAT PUMPS ARE CHEAPER THAN EFFICIENT GAS



AO Smith FCG-100 98 Gallon Promax High Recovery 6 Yr warranty Residential Water Heater (Nat Gas)

from [SupplyHouse.com](#)

★★★★★ 108 product reviews

A.O. Smith · Tank · Natural Gas · 98 gallon

AO Smith FCG-100 ProMax SL High Recovery 98-Gallon Gas Water HeaterThe Promax Plus High Recovery gas water heater is designed for reliable performance, reduced NOx emissions and has 80% thermal efficiency. Featuring a 98-gallon tank and a 75,100 BTU gas burner, the FCG-100 standard vent delivers a thermal efficiency of 80%, and a recovery rate of 81 gallons per hour. [« less](#)

Other options ▾

\$2,125.95

Free shipping. No tax
[SupplyHouse.com](#)
 ★★★★★ (21,769)

\$1,825.01 [AF Supply](#)

\$2,545.48 [eBay - plumbingplanet](#)

[Compare prices from 3 stores](#)



Noritz CB180-DV-NG Residential Condensing Gas Combination Boiler

from [Faucet Depot](#)

Convertible to Single Vent (-SV) with th
 : Includes remote thermostat that can ..

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+\$147.79 tax. Free shipping

[Faucet Depot](#)

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GE GEH80DFEJSR GeoSpring Hybrid Electric Water Heater

from [Goedeker's](#)

★★★★★ 55 product reviews #2 in GE Water Heaters

GE · Tank · Electric · 80 gallon · Energy Star · Heat Pump

This is the new 80 gallon version of the popular GE GeoSpring Hybrid Heat Pump Water Heater in Louisville, Kentucky. Five operating modes ... [more »](#)

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\$1,897.00 [US Appliance](#)

\$1,915.00 [eBay](#)

[Compare prices from 5+ stores](#)

GAS VENTING AND GAS PLUMBING COSTS MAKE GAS MORE EXPENSIVE



Rheem EcoSense 36 in. Vent
Length 3 x 5 in. Stainless Steel
Concentric Venting Straight Vent
for Rheem Indoor Tankless Gas
Water Heaters

Model# RTG20151D-1

NOT YET RATED

\$44²⁸



Rheem EcoSense 3 in. x 5 in.
Stainless Steel Vertical
Concentric Termination Vent Kit
for High Efficiency Tankless Gas
Water Heaters

Model# RTG20211

★★★★☆ (3)

\$239⁰⁰



Rheem EcoSense 3 in. x 5 in.
Horizontal Stainless Steel
Concentric Termination Vent Kit
for Mid Efficiency Tankless Gas
Water Heaters

Model# RTG20210

★★★★★ (6)

\$89⁰⁰

Cost of Plumbing Indoor Gas Line to a Fixture: **\$250-800**

Cost of Venting Gas Exhaust: **\$270-\$850**

LESSONS: EARLY ALL-ELECTRIC ZERO NET ENERGY “JUST” BROKE EVEN

Danco Builders Cost Analysis for Net Zero Energy Construction vs. 15% Above T24 Code:
\$12,582/unit, no net debt increase

Construction Items	Cost Change for NZE vs. 15% above Code
High Performance Heat Pumps	\$ 3,066
HERS Commissioning	\$ 259
NZE Solar (after rebates)	\$ 9,689
Plumbing (heat pump 50 gal tanks)	\$ (758)
Extra Insulation	\$ 326
Cost Per Unit	\$ 12,582
ZNE Project Cost (35 Units)	\$ 440,370
Increased Rents = Decreased Utility Bills Results in Increased Construction/Permanent Loan	\$ 430,560

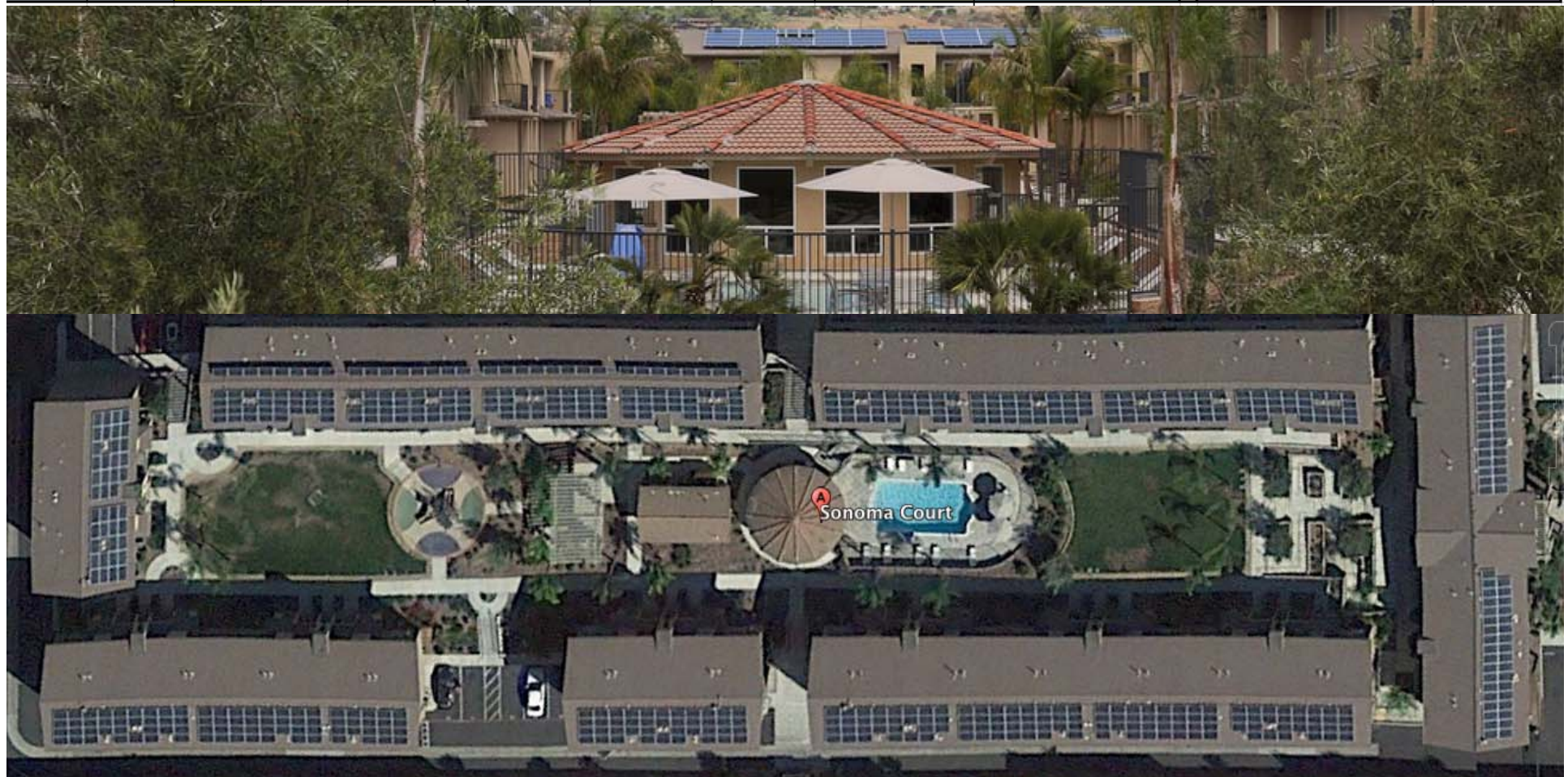


April, 2013: CHURCHILL TOWNHOMES, Fortuna: 35 family apartments. Danco Communities

Lesson: NZE construction in 2012 was cost-neutral

Sonoma Court Fuel Switching+ Solar PV Cost-Benefit Analysis

Bedroom Count	Unit Count	Monthly Electric Bill with PV OFFSET	Monthly Remaining GAS Domestic Hot Water Bill	Total Post-Fuel Switch Monthly Utility Allowances		Monthly Gas 80% AFUE Heating Bill now PV OFFSET via Electric Fuel Switch to HSPF 7.7 Heat Pump	Monthly Gas Cooking Bill now PV OFFSET via Electric Fuel Switch to Electrid Range and Oven	Total Monthly Utility Allowance Offset by Fuel Switch to Electricity and PV Offset	Total Annual Utility Allowances Offset by Fuel Switch to Electricity and PV Offset, and Multiplied by Unit Count	Total Annual Utility Allowances Offset by Fuel Switch and PV Offset, then Multiplied by 15 to Calculate the Additional Permanent Loan Available to Pay for the Fuel Switch	Summary of Financial Benefit vs. Cost	
						\$	\$	\$	\$	\$		
1	1	\$ 5.17	\$14.23	\$19.40		\$ 7.68	\$ 10.86	\$ 18.54	\$ 222	\$ 3,337	Total Permanent Loan Increase Due to Fuel Switch and PV Offset	\$ 213,125
2	36	\$ 5.42	\$16.06	\$21.48		\$ 7.98	\$ 12.05	\$ 20.03	\$ 8,653	\$ 129,794	Construction Cost to Fuel Switch the HVAC + Cooking + Additional PV for Offset (provided by Affirmed VP of Construction)	\$ 25,410
3	19	\$ 5.17	\$16.06	\$21.23		\$ 10.36	\$ 13.03	\$ 23.39	\$ 5,333	\$ 79,994	Net Financial Benefit from Fuel Switch	\$187,715



SONOMA COURT, ESCONDIDO: HVAC AND COOKING FUEL SWITCH

Recommended Improvements	Description	Savings	
		Site	TDV
Windows	Type = High Performance windows U-Factor = 0.310 SHGC = 0.3	15.8 %	17.7 %
HVAC System	Name = Carrier Corp. 25HBC324(A,W)**30 Type = Split DX Heating = Split Heat Pump Efficiency = 7.70 HSPF Cooling = Split Heat Pump SEER = 13.00 EER =	23.9 %	15.3 %
HVAC Duct Leakage	Leakage = 15 % Leakage Rate at 25 Pascals = 119 cfm	6.5 %	8.3 %
Domestic Hot Water Heater	Name = Gas Tank - 0.70 EF Type = Gas Fired Volume = 40.0 gal Efficiency = 0.700 EF	8.5 %	4.3 %
All Improvements	All Energy Efficiency Upgrades Included	43.1 %	38.3 %



Carrier 3 Ton 14
from ACWholesalers.com

Carrier · Heat Pump · V

Overview for Carrier CH years of design, develo

See more details at AC

\$2,252.00
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ETHAN TERRACE: SAVING ENERGY AND COSTS WITH ELECTRIFICATION



Energy Upgrade Recommendations

ECON-2

Project Name	<i>Ethan Terrace Apartments</i>	Documentation Author	<i>Redwood Energy</i>
Project Address	<i>1820-1824 Ethan Way SACRAMENTO, ca 95825</i>	Author Address	

Recommended Improvements	Description	Annual Savings	Est. Cost to Install	Savings	
				Site	TDV
<i>HVAC System</i>	<i>Name = LG LW1815HR PTAC w/resistance heat Type = Room PTAC Heating = Electric Efficiency = 3.41 HSPF Cooling = Room PTAC with Side Louvers SEER =</i>	\$0	\$0	19.9 %	15.7 %
<i>Domestic Hot Water Heater</i>	<i>Name = A O Smith Water Products BTH 199A Type = Gas Fired Volume = 100.0 gal Efficiency = 0.970 %</i>	\$0	\$0	3.9 %	2.1 %
<i>All Improvements</i>		\$0	\$0	23.7 %	17.8 %

Retrofit Activity	Construction Cost	Incremental Cost Compared to PTAC	Incremental Cost per Unit (96 Units)
Cost of Intalling PTACs with Resistance Heat	\$ 202,400	\$ 14,400	\$ 150
Cost of Upgrading service to PTACs to 220V	\$ 34,960	\$ 34,960	\$ 364
Avoided Cost of Wall Furnaces	\$ 144,000	\$ (144,000)	\$ (1,500)
Cost of removing Wall Furnaces, Drywall Patching, Texture and Paint	\$ 19,320	\$ 19,320	\$ 201
Total		\$ (75,320)	\$ (785)

BRIDGEVILLE ELEMENTARY



Mitsubishi MZ-FH18NA

from ACWholesalers.com

Mitsubishi · Mini-split · Heat Pump

The Mr. Slim series from Mitsubishi is the perfect way to cool or heat ...

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BRIDGEVILLE ELEMENTARY ENERGY AND COST SAVINGS

Energy Upgrade Recommendations

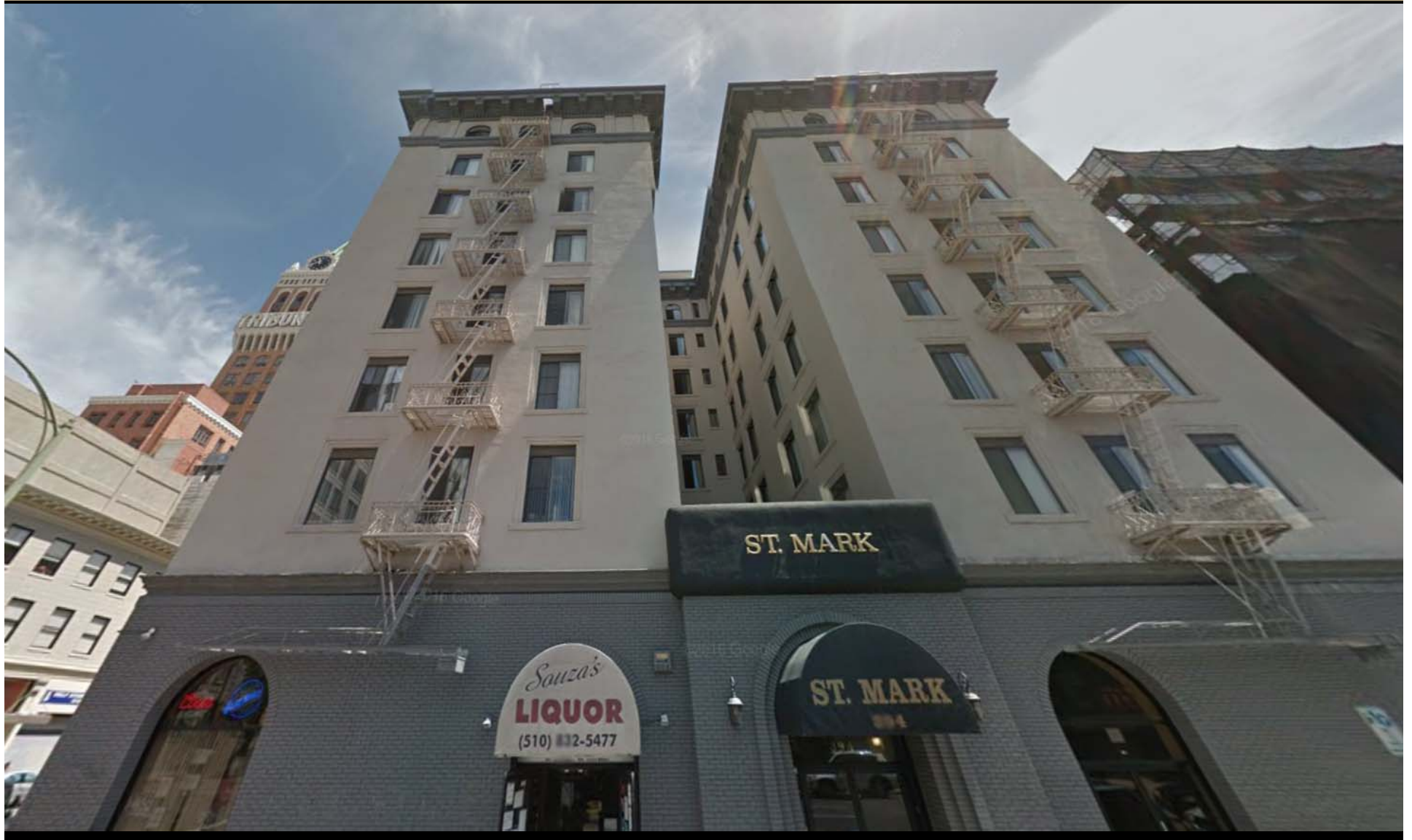
ECON-2

Project Name <i>Bridgeville School</i>	Documentation Author <i>Redwood Energy</i>
Project Address	Author Address

Recommended Improvements	Description	Annual Savings	Est. Cost to Install	Savings	
				Site	TDV
<i>HVAC System</i>	<i>Name = Mitsubishi MUZ-FH18NA Type = Split DX Heating = Split Heat Pump Efficiency = 11.20 HSPF Cooling = Split Heat Pump SEER = 20.50 EER = 11.20</i>	\$961	\$0	11.7 %	11.6 %
<i>HVAC Distribution</i>	<i>Heating Distribution = Ductless / with Fan Cooling Distribution = Ductless Duct Location = Attic, Ceiling Ins, vented Leakage Type = Duct Leakage not Verified</i>	\$102	\$0	1.5 %	1.4 %
<i>All Improvements</i>		\$1,050	\$0	12.3 %	12.6 %

	Annual Cost savings	Annual kWh savings	Annual therms savings
Space heating	\$ 153.00	-904.00	226.00
space cooling	\$ (328.00)	-1839.00	0.00
Fans	\$ 1,131.00	6392.00	0.00
Totals	\$ 956.00	3649.00	226.00

HOTEL ST. MARK, OAKLAND



ELECTRIFICATION OF CENTRAL DOMESTIC HOT WATER

Energy Upgrade Recommendations

ECON-2

Project Name <i>St. Marks Hotel</i>	Documentation Author <i>Redwood Energy</i>
Project Address <i>394 12th Street Oakland, CA 94607</i>	Author Address

Recommended Improvements	Description	Annual Savings	Est. Cost to Install	Savings	
				Site	TDV
<i>Domestic Hot Water Heater</i>	<i>Name = Sanden HPWH 3.40 Type = Heat Pump Volume = 200.0 gal Efficiency = 3.400 EF</i>	\$0	\$0	41.6 %	18.4 %
<i>Windows</i>	<i>Type = Upgraded Windows U-Factor = 0.250 SHGC = 0.3</i>	\$0	\$0	15.0 %	20.7 %
<i>Domestic Hot Water Heater</i>	<i>Name = copy of Laars HH0500EN04*BA Type = Gas Fired Volume = 0.0 gal Efficiency = 0.650 %</i>	\$0	\$0	-8.5 %	-3.5 %



DELIVERANCE TEMPLE, RICHMOND: COST-EFFECTIVE ELECTRIFICATION



111. 40-amp 2-pole 40-amp 2-pole Circuit Breakers



113. Temple I Unit Circuit Breaker Panel

DELIVERANCE TEMPLE: COST EFFECTIVE DHW RETROFIT

Recommended Improvements	Description	Annual Savings	Est. Cost to Install	Savings	
				Site	TDV
Wall Insulation	Type = R-15 Wall Cavity Insulation = 15.0 R-Value Interior Insulation = 0.0 R-Value Exterior Insulation = 0.0 R-Value	\$8,294	\$0	34.2 %	34.5 %
HVAC System	Name = Electric Resistance Type = Split DX Heating = Electric Efficiency = 3.41 HSPF Cooling = No Cooling SEER = 8.00 EER = 6.40	(\$59,290)	\$0	22.2 %	-25.0 %
Domestic Hot Water Heater	Name = Sanden HPWH 3.40 Type = Heat Pump Volume = 500.0 gal Efficiency = 3.400 EF	\$159	\$0	15.5 %	10.3 %
All Improvements		(\$20,546)	\$0	60.5 %	32.7 %



Introducing
North America's first eco-friendly
CO₂ hot water solution



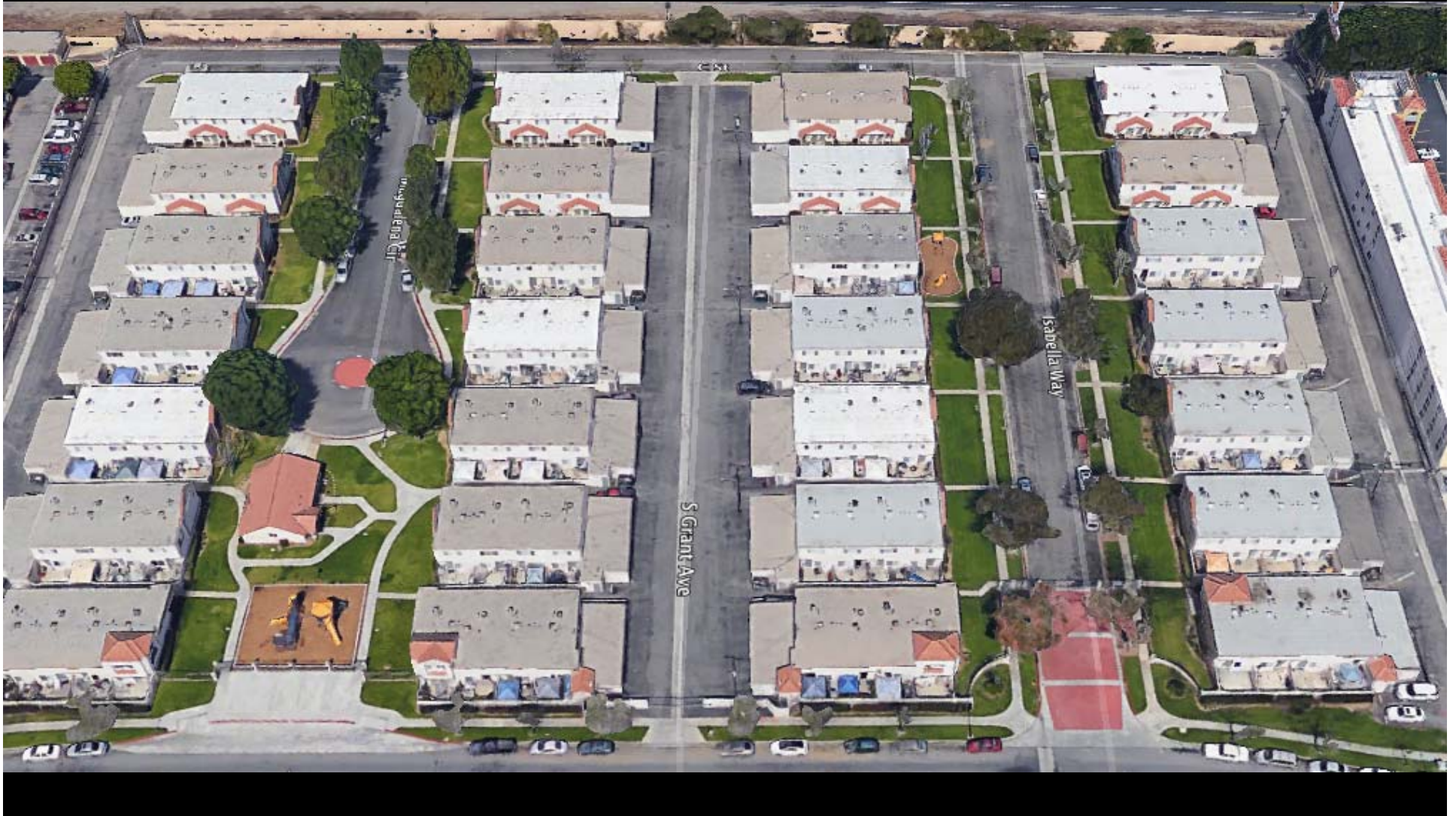
Introducing
North America's first eco-friendly
CO₂ hot water solution



MONTERREY PINES, RICHMOND: 324 APARTMENTS WITH ELECTRIC DHW



CORONA DEL REY DEEP FUEL SWITCH AND ZNE ARRAY



CORONA DEL REY BENEFITS FROM LIWP FUNDS FOR CO2

LIST OF RECOMMENDED ENERGY CONSERVATIONS MEASURES

Corona Del Rey		LIWP Incentive Worksheet \$4500 per Metric Ton CO2				
	Measure	Estimated Installed Cost	Site Energy Savings %*	GHG Savings (MTCO2)	Completion Date	LIWP Incentive
PLANNED ENERGY SAVINGS MEASURES						
1	Cool roof and R-19 Insulation	\$774,000	4.5%	29.9	after April 2017	\$134,561.18
2	Dual Pane Code Compliant Windows	\$384,000	6.6%	61.6	after April 2017	\$277,247.52
3	High Efficiency Heat Pump Water Heaters	\$300,000	3.0%	17.7	after April 2017	\$324,255.18
4	Demand Controlled Recirculation Pumps	\$50,000	0.4%	3.1	after April 2017	\$10,688.52
5	Insulate All Accessible DHW Piping	\$10,050	1.4%	8.6	after April 2017	\$29,983.25
6	Low Flow Showerheads and Aerators	\$810	0.3%	2.0	after April 2017	\$6,934.44
7	High Efficiency Heat Pumps	\$960,000	29.8%	183.5	after April 2017	\$825,950.28
8	Seal and Clean All Accessible Ducting	\$240,000	9.4%	60.5	after April 2017	\$272,040.78
9	LED Unit Lighting	\$465,500	0.7%	8.1	after April 2017	\$36,327.46
10	LED Common and Exterior Lighting	\$465,600	1.6%	16.6	after April 2017	\$58,051.41
11	Front Loading Energy Star Tier 3 Washing Machines (8)	\$12,000	0.5%	3.7	after April 2017	\$13,045.33
Totals		\$3,661,960	73.0%	470.1		\$1,989,085.33

France: Gas explosion in building linked to apparent attempted suicide



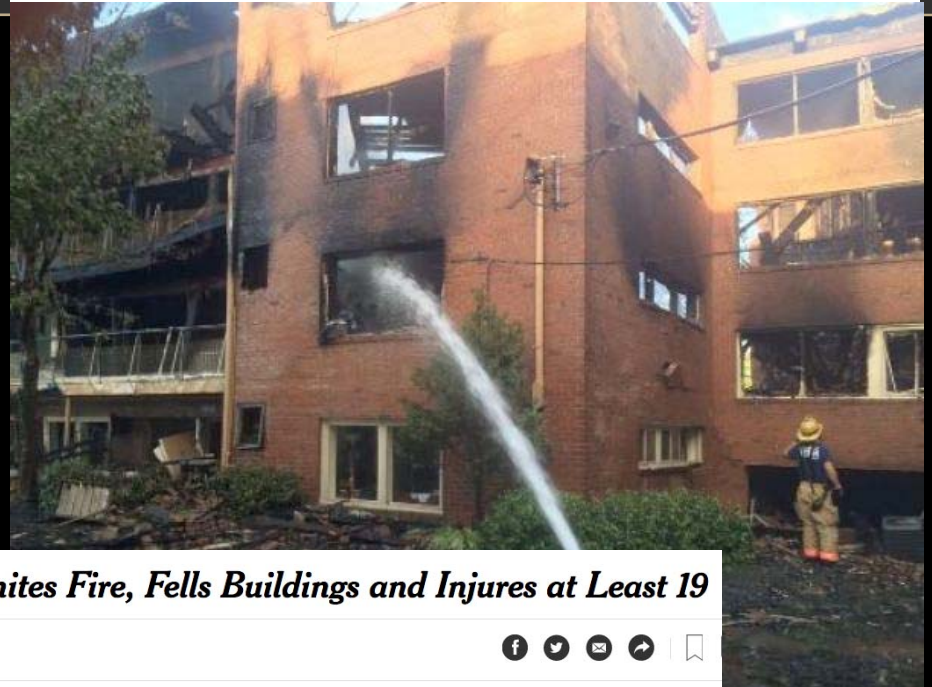
French firefighters work in the rubble on Pierre Palliot Street in Dijon, France, after a gas explosion destroyed a building on Sept. 16, 2016. / ROMAIN LAFABREGUE/AFP/GETTY IMAGES

Police & Fire

Final Victim Identified in Silver Spring Apartment Explosion

Investigators say a natural gas leak caused an explosion and fire that killed seven people; identity has been confirmed.

By Deb Belt (Patch Staff) - September 21, 2016 6:10 pm ET | P



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San Francisco Chronicle

California's Best Large Newspaper AS RATED BY THE CALIFORNIA STATE BOARD OF PUBLICATIONS | 5000 *****

Inferno

At least 1 dead as PG&E line explodes, fire levels San Bruno neighborhood



East Village Explosion Ignites Fire, Fells Buildings and Injures at Least 19

By MARC SANTORA and AL BAKER MARCH 26, 2015



Witness videos show the scene in the East Village after an explosion caused a fire on Second Avenue, affecting neighboring buildings. March 26, 2015. Photo by Nancy Borowick for The New York Times. Watch in Times Video >

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QUESTIONS?



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