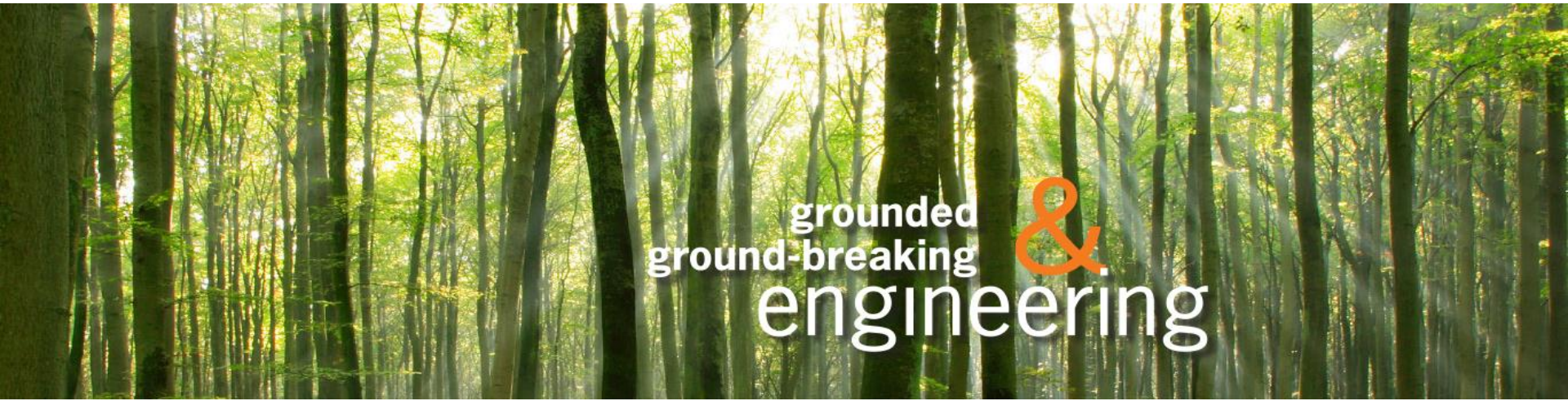
THE DECARBONIZATION REVOLUTION



Guttmann & Blaevoet
CONSULTING ENGINEERS

grounded
ground-breaking
&
engineering

Ted M. Tiffany

LEED AP BD&C
Principal
Director of Sustainability

Technology & Design for Decarbonization

Guttmann & Blaevoet
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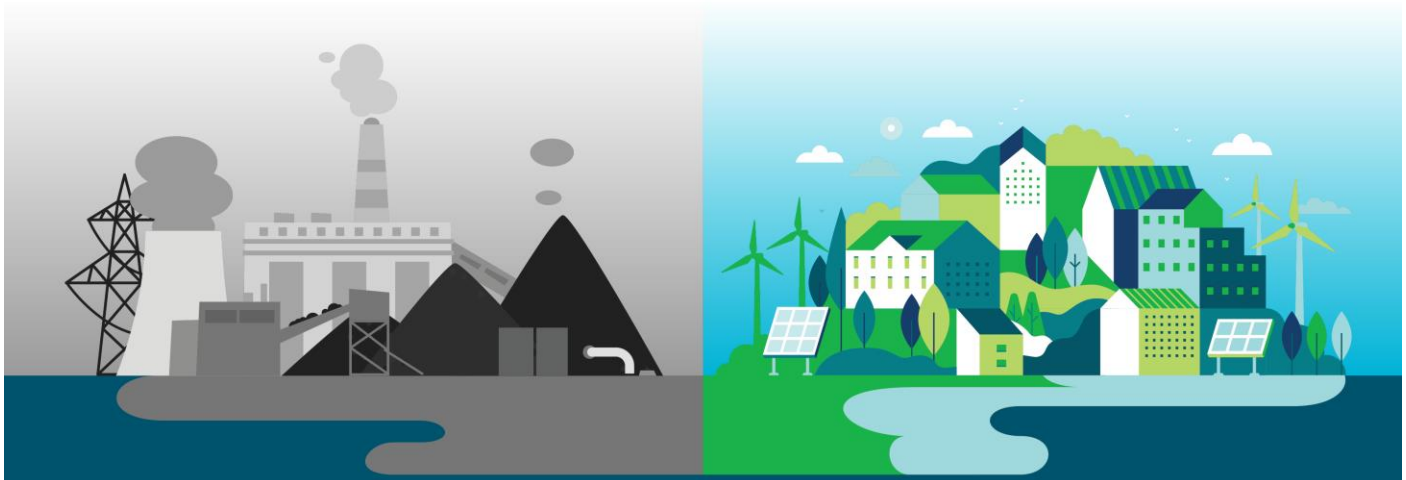


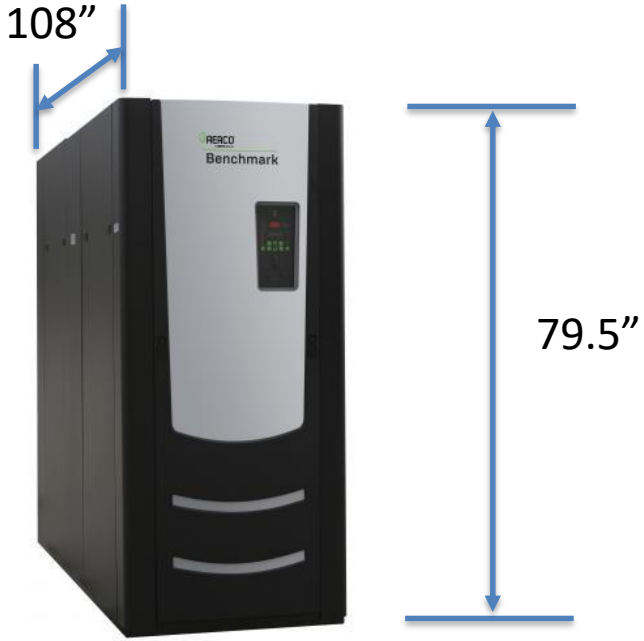
DESIGN PROFESSIONAL'S GUIDE TO

DECARBONIZATION OF THE BUILT ENVIRONMENT

PRIMER DOCUMENT – MARCH 2020

Google Microsoft Healthy Buildings AIA California Council WRNS STUDIO URBANFABRICK WILLIAM J WORTHEN FOUNDATION

Equipment Space – Boiler



6,000,000 BTUH

Myth Busting: Electric Boiler vs. Gas Boiler

6,000,000 BTUH

6,000,000 BTUH

Myth Busting: Air-Source HPWH vs. Boiler

6,000,000 BTUH

6,000,000 BTUH

Equipment Space – Air-Source HPWH vs. Boiler

1,500,000 BTUH + 9,000 gallons

6,000,000 BTUH

ECOTOPE

SHAWN ORAM, PE

Director of Engineering & Design

HEAT PUMPS ARE NOT BOILERS

- Efficiency impacted by Air and Water Temps
- Limited Temperature Ranges
- Output temperature limited
- Different refrigerants for different applications
- Larger Hot Water Plant Footprints
- Expensive Oversize
- Require Right Sizing (Both Loads)
- Shouldn't cycle more than 6x/Hr
- Defrost Cycles
- Complex Controls

Heat Pumps are Not Boilers

MARKET DEVELOPMENT NEEDS

ECOTOPE.COM

DESIGN TOOLS

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

BUILDING DECARBONIZATION COALITION

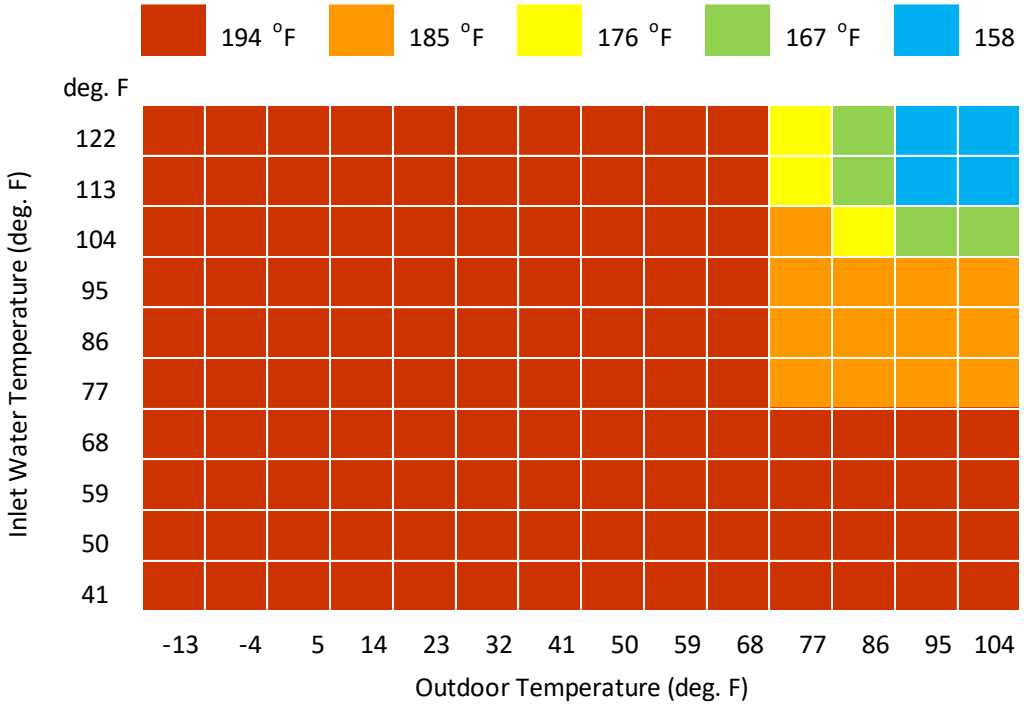
CALIFORNIA ENERGY COMMISSION

Redwood Energy
Foremost Zero Net Energy Specialists in Multifamily Housing

Guttmann & Blaevoet CONSULTING ENGINEERS

ECOTOPE

Myth Busting: Heat Pumps CAN'T work in cold climates and can't produce enough hot water



CO_2

Heat Pumps CAN Produce 140+ deg. F Water EVEN WELL Below Freezing with the right selection

Myth Busting: Not Enough Products on the Market

Stiebel Eltron Accelera
58 and 80 gallon

Rheem Prestige
50 and 80 gallon

GE Geospring
50 and 80 gallon

Hubbell PBX
40, 50, 65, 80, 119 gallon

AO Smith Voltex
50, 66, and 80 gallon

Sanden $SANCO_2$
43 and 83 gallon

SMALL PROJECTS

SMALL HPWH

CENTRAL SYSTEMS DOMESTIC HOT WATER

Colmac
66 to 270 MBH

Nyle Geyser C-Series
28.6 to 272 MBH

Mayekawa Unimo AW
204 MBH

Mitsubishi QAHV
136 MBH

SMALL PROJECTS

CENTRAL AIR-SOURCE HPWH

CENTRAL SYSTEMS DOMESTIC HOT WATER

Nyle Geyser C-Series
28.6 to 272 MBH

Mayekawa Unimo WW
270 MBH

Colmac
37 to 1,000 MBH

SMALL PROJECTS

CENTRAL WATER-SOURCE HPWH

DHW & LARGE CENTRAL HEATING/COOLING PLANTS

Air-Cooled

Water-Cooled

Aermec NRP/NRL
50 to 130 TR

Climacool UCA
20 to 420 TR

Multistack DRHC
10 to 1,320 TR

LARGE PROJECTS

HEAT RECOVERY CHILLER PLANTS

ELECTRICAL SERVICE IMPACTS

Assumed Electric Boiler

7.	BUILDING COMMON AREA LOADS:				
	A.	EV CHARGER SYSTEM	=	298080 Watts	
	B.	REACH HOT WATER SYST.	=	448000 Watts	
	C.	25% LARGEST	=	13650 Watts	
	D.	TOTAL HOUSE LOAD:	=	2110.4 A @ 3 PH. =	**759730** VA
8.	TOTAL BUILDING SERVICE 1 DEMAND LOAD:				**1297789** **W**
9.	TOTAL BUILDING DEMAND AMPS:				**3605.0** **A**
	(AT 120/208V, 3 PH., 4W. SERVICE)				
10.	BUILDING MAIN SWITCHBOARD MSB1:				
	A.	MAIN SWITCHBOARD "MSB1":			**4000** A, 120/208V, 3 PH., 4W.
	B.	MAIN SERVICE SIZE:			**4000** A, UTILITY SERVICE

Central Heat Pump Water Heater

7.	BUILDING COMMON AREA REACH LOADS:				
	A.	EV CHARGER SYSTEM	=	130560 Watts (34 @ 16A)	
	B.	REACH HOT WATER SYST.	=	144960 Watts (120+24CONT)	
	C.	25% LARGEST	=	13650 Watts	
	D.	TOTAL HOUSE LOAD:	=	803.3 A @ 3 PH. =	**289170** VA
8.	BUILDING COMMON AREA LOADS:				
	A.	PANELS "2H""2H1"	=	132298 Watts	
	B.	PANELS "1H""5H""9H"	=	212224 Watts	
	C.	PANELS 2LR, 2E	=	54090 Watts	
	D.	ROOF AH UNIT	=	33840 Watts	
	E.	3 ELEVATORS @ 25HP	=	69750 Watts	
	F.	125% LARGEST MOTOR	=	34000 Watts	
	G.	25% HOUSE LTG.	=	9994 Watts	
	H.	TOTAL HOUSE LOAD:	=	1517.2 A @ 3 PH. =	**546196** VA
9.	TOTAL BUILDING SERVICE 1 DEMAND LOAD:				**1310191** **W**
10.	TOTAL BUILDING DEMAND AMPS:			= 90.99%	**3639.4** **A**
	(AT 120/208V, 3 PH., 4W. SERVICE)				
11.	BUILDING MAIN SWITCHBOARD MSB1:				
	A.	MAIN SWITCHBOARD "MSB1":			**4000** A, 120/208V, 3 PH., 4W.
	B.	MAIN SERVICE SIZE:			**4000** A, UTILITY SERVICE

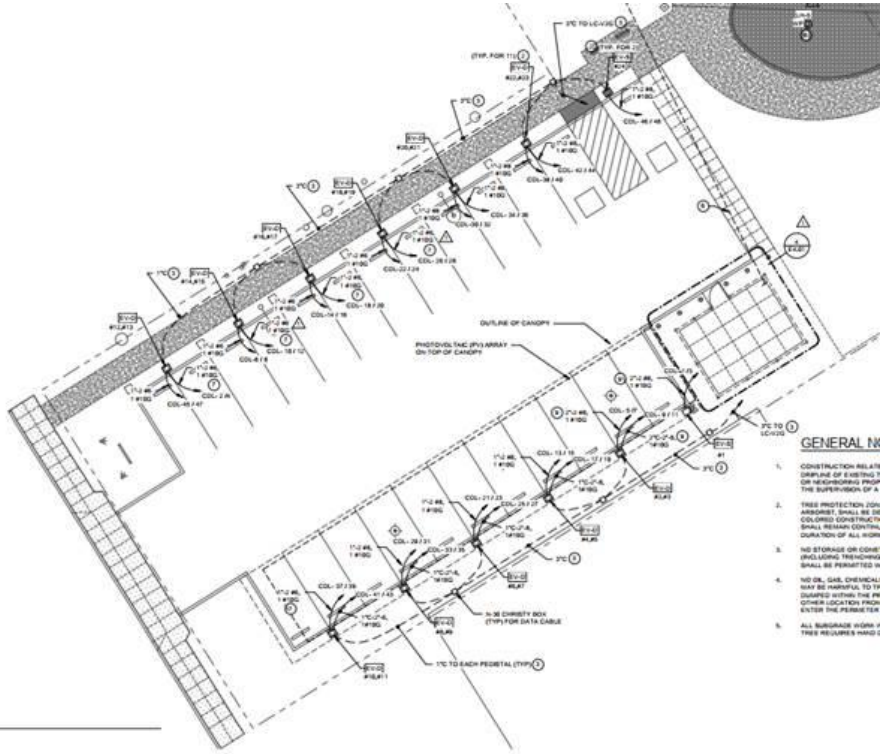
448kW for Assumed Electric Boiler

Heat Pumps 144kW 67% Lower Service Size

EXTRA SERVICE NEEDED FROM UTILITY

STAYS WITHING EXISTING DESIGN SERVICE

ELECTRICAL SERVICE IMPACTS



EXTRA SERVICE NEEDED FROM UTILITY?

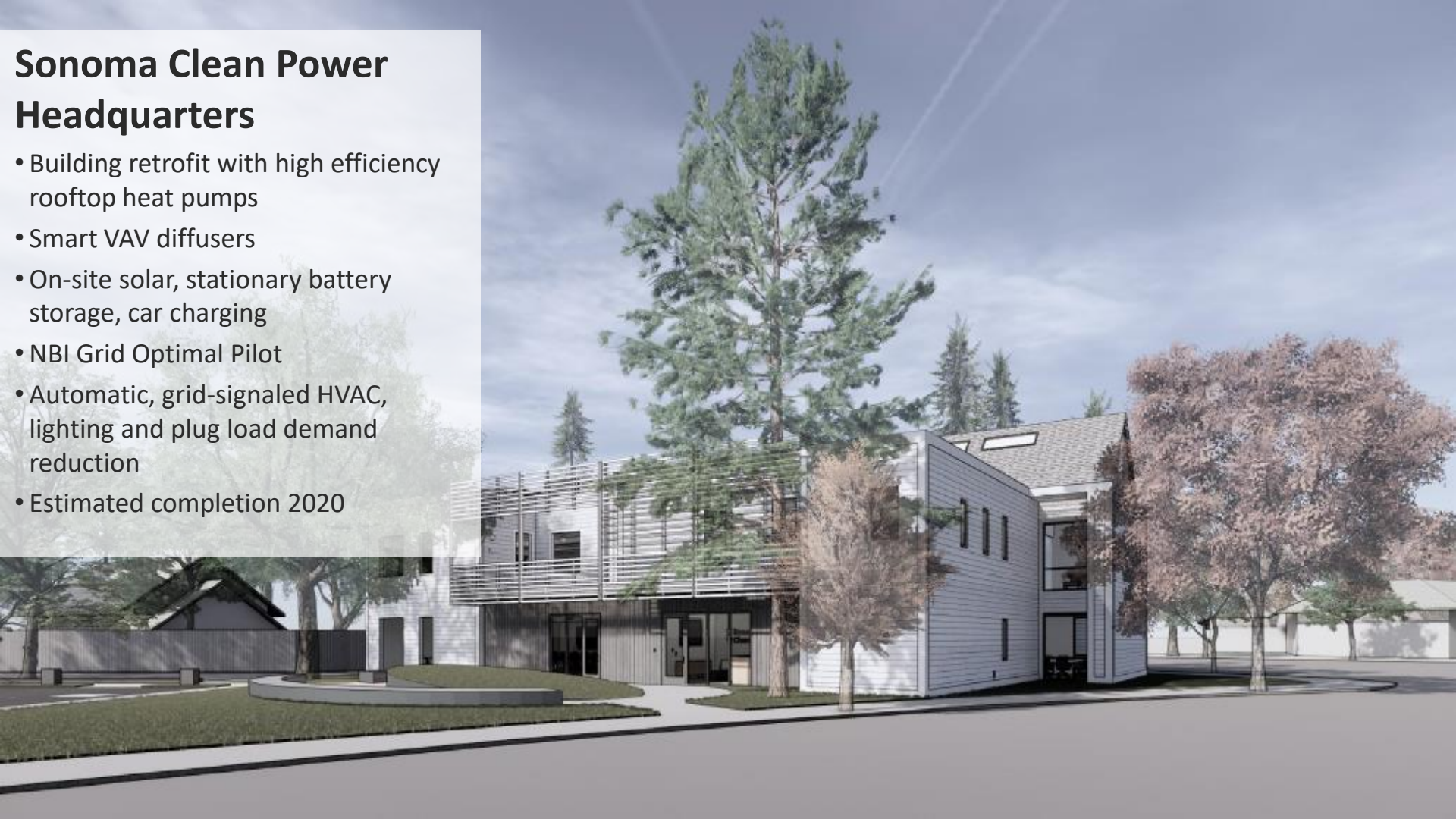
Planning for future EV Stations= Future Capacity?

STAYS WITHING EXISTING DESIGN SERVICE?

Service for minimal charging stations

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



SMUD East Campus Operations

- 350,000 SF ZNE Campus
- No gas on site
- Shades allowed zero infiltration for direct solar
- Use of ceiling fans and chilled beams to minimize reheat
- Use of thermal mass to offset peak demand
- Evap cooling, natural ventilation
- Radiant heating
- Horizontal geofield
- Modular heat pump chillers to concurrently produce chilled and hot water with below ground storage for both
- PV array for 100% the electrical load
- Solar Thermal DHW
- Grey Water System
- Completed in 2014

Silver Oak Winery

- Healdsburg
- Winery production, visitor center/tasting room, onsite water reuse facility
- Central Heat Pump Water Heating
- On-site solar
- Car charging
- Ammonia Chillers for Process Cooling
- Onsite Wastewater Treatment
- Zero Net Energy
- Zero Net Water
- Completed 2019

Silver Oak Winery

LIVING BUILDING CHALLENGE℠

Silver Oak Energy Use Breakdown

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

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

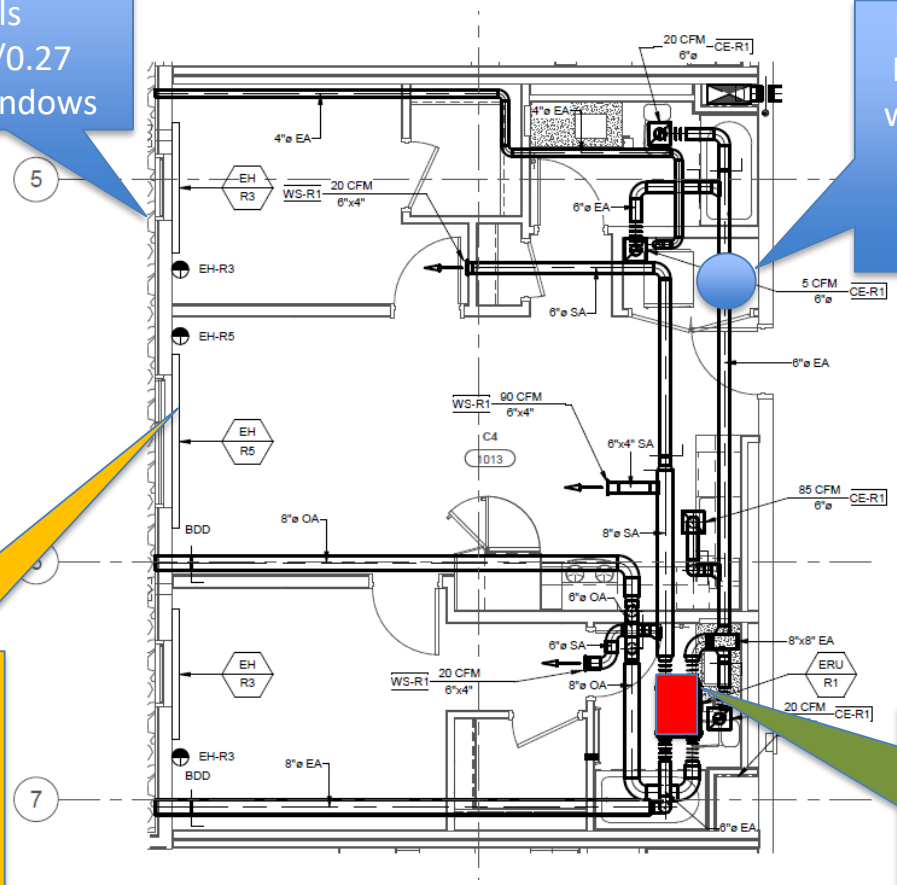
- All-electric design
- Rooftop Heat Pump for HHW
- Low Temp DX Cooling Rooftop Unit
- Smart VAV diffusers
- Electric Radiant Heat with ERV for Residential
- Estimated completion 2021

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 FREE COOLING if Needed Or Exhausted



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

Energy Recovery Ventilator 69% Sensible Heat Recovery Effectiveness

UCSF Minnesota Housing Commissioning

- 333 Beds of Housing
- 4 Nyle Heat Pumps
- Storage tanks in the basement
- All Electric Kitchens

System Specs (Each Unit)

- Entering Water Temperature: 60F
- Leaving Water Temperature: 140F
- Entering Air Temperature: 70F
- Heating Capacity: 262,600 BTU/hr
- Cooling Capacity: 207,100 BTU/hr\
- Power Input: 20 kW
- Heating C.O.P: 4.15
- Cooling C.O.P: 3.3
- Combined C.O.P: 7.45

Questions?

THANK YOU!

grounded
ground-breaking
&
engineering

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Principal
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