CLIMATE ACTION WEBINAR

DESIGNING FOR ZERO NET CARBON | ALL-ELECTRIC AFFORDABLE HOUSING

AIA California

ZERO NET CARBON MANDATORY CONTINUING EDUCATION

MODERATOR:

JAMIE STEINMETZ

LEED AP
SENIOR ASSOCIATE | PAUL HALAJIAN ARCHITECTS

SPEAKER:

ED DEAN

FAIA, LEED AP BD+C, PhD
PRINCIPAL | BERNHEIM + DEAN, INC

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AIA California

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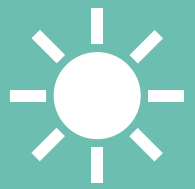
Learning Objectives

Biophilia in the Workplace

Understand the impact on carbon emissions attributable to both building construction and building operation in multifamily housing.

Review zero-carbon examples of the practical application of energy-efficient design strategies and all-electric systems for heating, cooling, and domestic hot water in affordable housing projects.

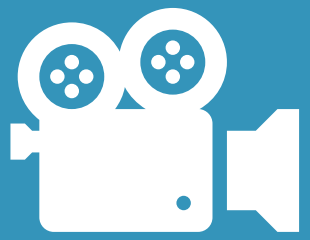


Determine how on-site renewal energy can be incorporated in a cost-effective way to support low energy and zero carbon performance.

See examples of how different sized affordable housing projects affect the design approach and the systems selected for a cost-efficient final design.

AIA Continuing Education Provider

Housekeeping Reminders



A recording of today's presentation will be made available on our website

Today's session qualifies for 1.5 AIA HSW/LU & 1.5hrs of ZNCD

Please use the Q&A function to ask questions for today's presenters

Cultivate a positive learning environment

MODERATOR

JAMIE STEINMETZ

LEEP AP

SENIOR ASSOCIATE | PAUL HALAJIAN ARCHITECTS

SPEAKER

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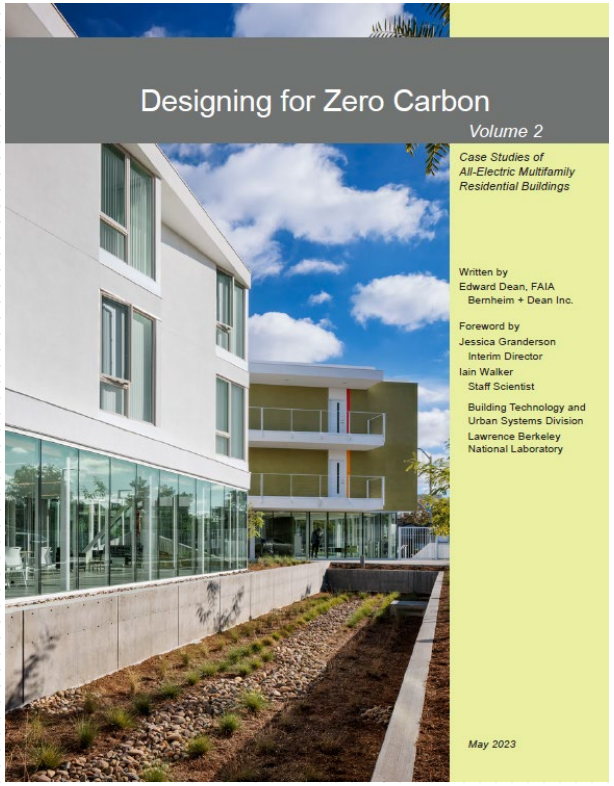
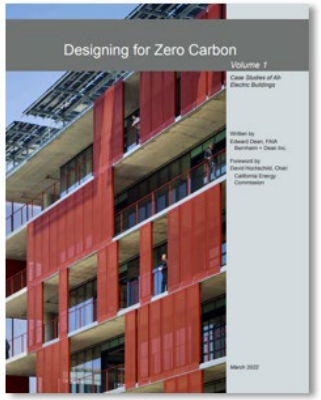
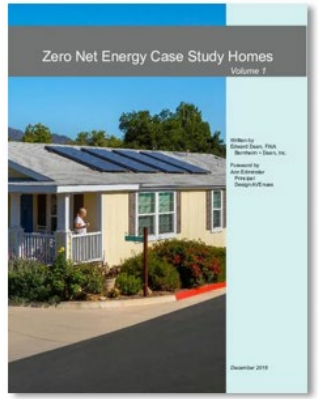
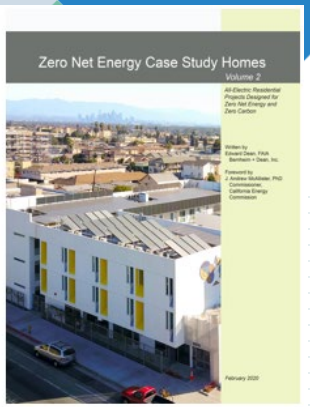
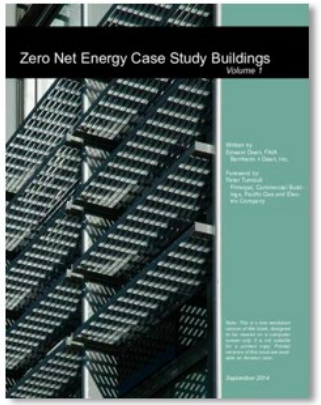
CalBEM

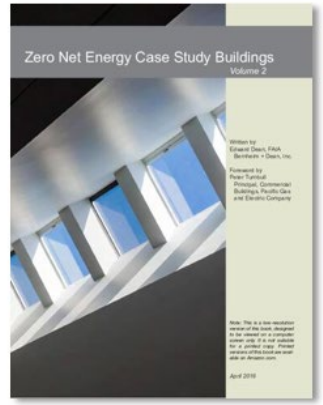


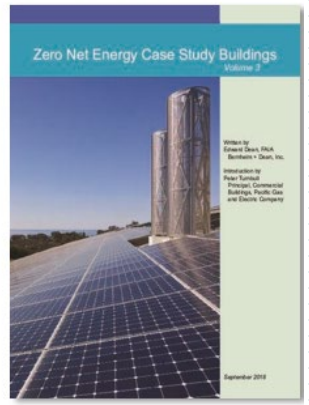












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California Building Energy Modeling

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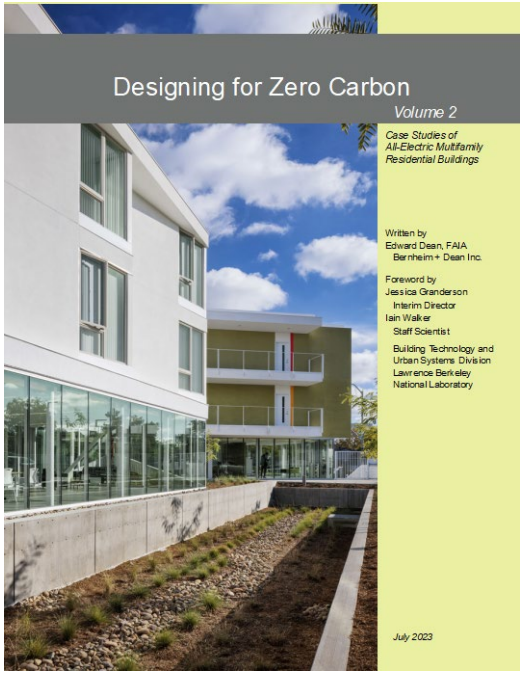


Designing for Zero Carbon — Three Case Studies of All-Electric Affordable Housing

AIA CEU WEBINAR

19 July 2023

Bernheim + Dean, Inc.
Sustainable Building Consultants

Webinar Contents

Introduction — Affordable Housing in California
— Common Structure of the Case Studies

1. Case Study No. 1 — Ivy Senior Apartments, San Diego (New)
2. Case Study No. 2 — Vera Cruz Village, Richgrove - Central Valley (Renovation)
3. Case Study No. 3 — Casa Adelante – 2060 Folsom, San Francisco (New)

Q & A

Introduction — Affordable Housing in California

Definition of Affordable

Tenant Groups

California Income Groups and Housing

“Affordable Housing” – Formal Definitions

- *Affordable Housing* for a specific *social group* is defined as housing with a maximum rent that is defined by the percentage of the *Area Median Income (AMI)* defined for that specific social group.

- The *Area* is geographically defined by the U.S. Department of Housing and Urban Development (HUD).

- The *AMI* for this Area is defined as the midpoint of the Area’s income distribution (the *Median*).

- The social groups based on income as defined by HUD are:

Extremely Low Income	30 Percent AMI or Less
Very Low Income	31-50 Percent AMI
Low Income	51-80 Percent AMI
Moderate Income	81-120 Percent AMI
Above Moderate Income	>120 Percent AMI

- Typically, *affordable housing* is discussed in terms of the first three income levels in the table.

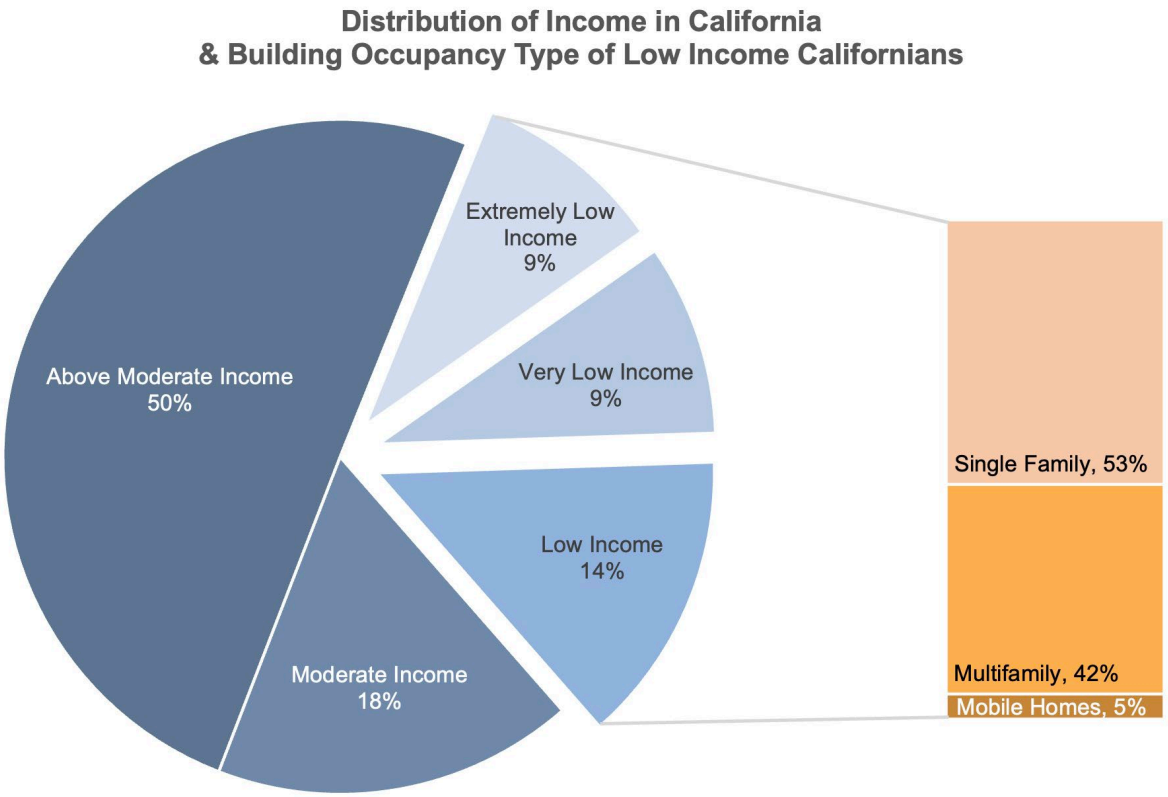
“Affordable Housing” – Tenant Groups

- In addition to income-based criteria, there are often additional social needs identified for *affordable housing* programs.

- In these three case studies, the following social groups are the intended target users:
    - Low-Income Seniors
    - Low-Income Farmworkers
    - Low-Income Residents of a specific city district
    - Transitional-Age Youth (TAY) – former foster-care children

“Affordable Housing” – California Income Groups and Housing

- 1/3 of Californians live in Low-Income households
- 42% of them live in Multifamily Buildings



Source: R. Rayef, “Home Equity and Building Decarbonization in California”, https://www.veloz.org/wp-content/uploads/2021/09/Housing-Equity-and-Building-Decarbonization_FINAL_Sept-2020-1.pdf

Introduction — Common Structure of the Case Studies

Project Background

Design Strategies - Zero Carbon (Operation) and Energy Efficiency

Renewable Energy Sources

Measured Energy Performance

Post-Occupancy Observations and Evaluation

Case Study No. 1 — Ivy Senior Apartments (New)

San Diego

1

Project Background

- *The User:*

Formerly Homeless Seniors

- *The Client:*

Wakeland Housing and Development Corporation, San Diego
(Non-Profit dedicated to building and managing affordable housing throughout California)

- *Project Goals — Zero Carbon (Operation) and Energy-Efficiency:*

High indoor air quality for seniors with health issues

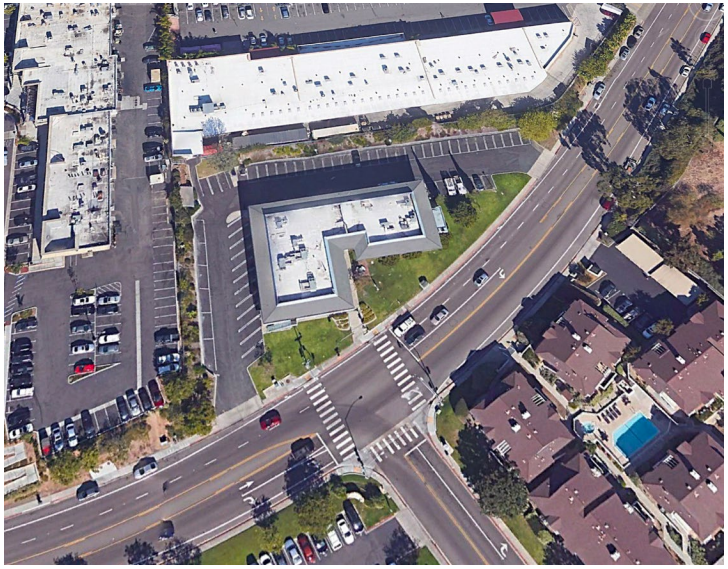
- *The Building Program:*

Studio apartments all of which meet accessibility code requirements, health service facilities, dining and kitchen common areas, large laundry room, administrative spaces. Parking for staff and visitors only.

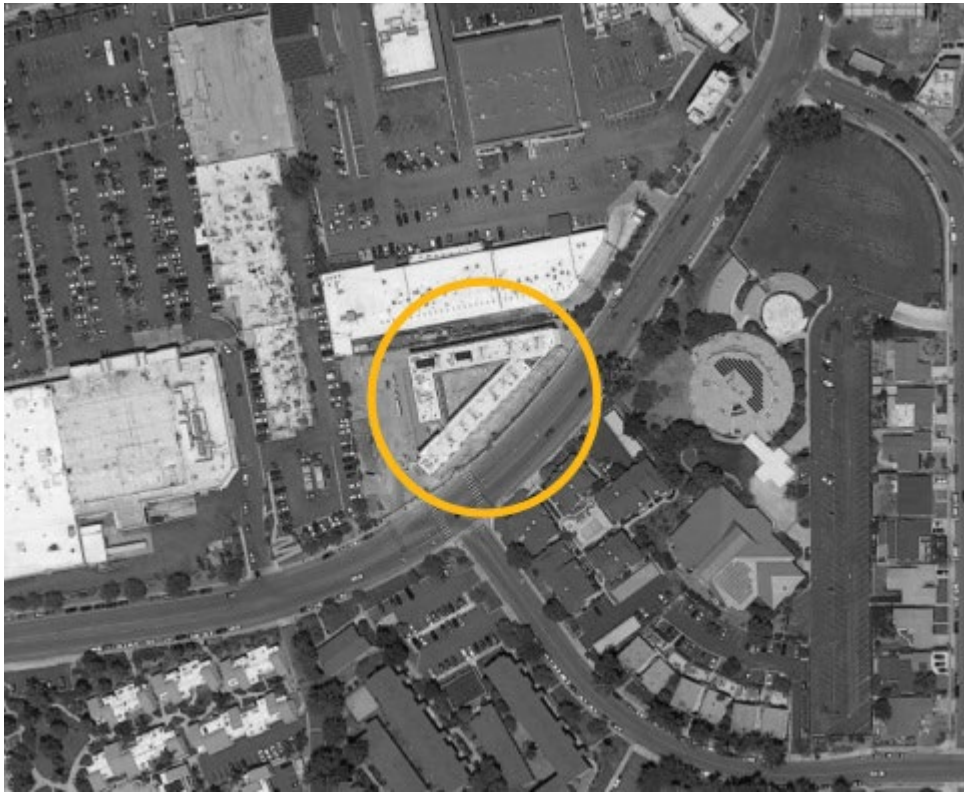
As built: 52 studio apartments for users and one 2-BR apartment for the on-site manager.

Project Background

- Site Vicinity



Vicinity - Before



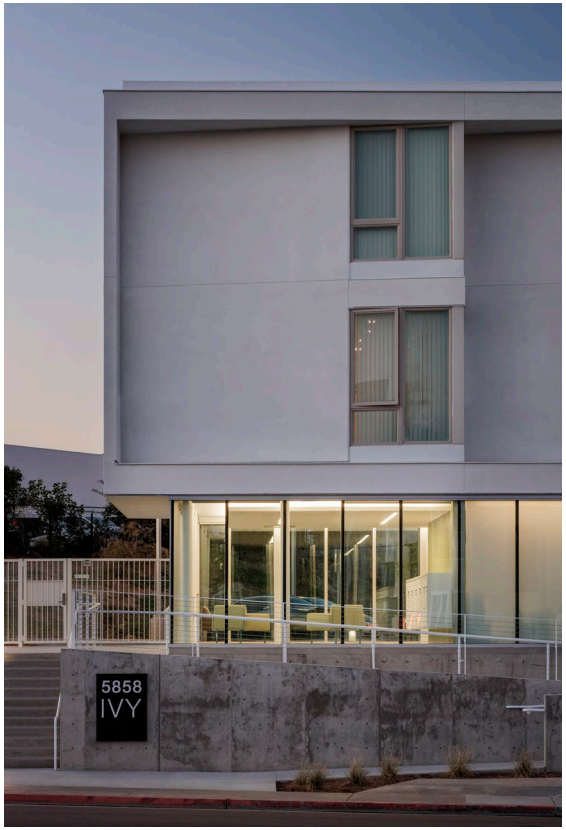
Vicinity - After

Project Background

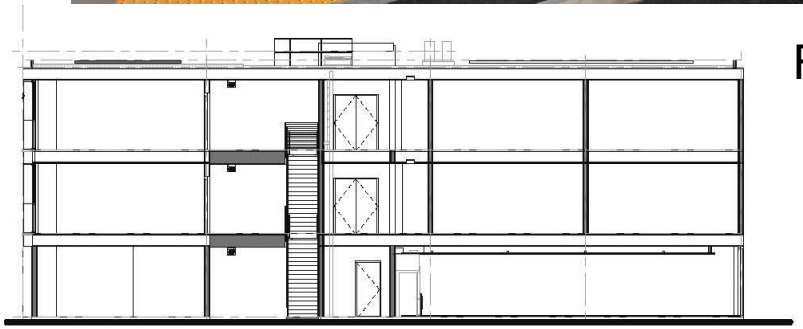
- Site Plan

Project Background

- Design Views



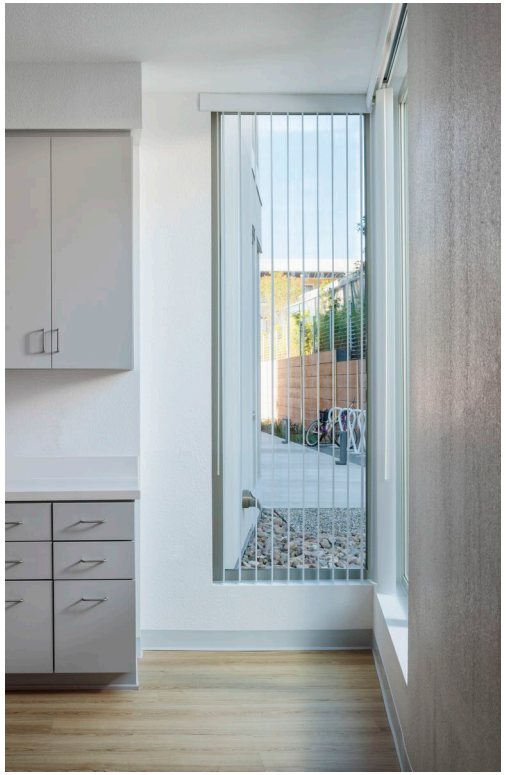
From Southeast and
Mt. Alifan Drive



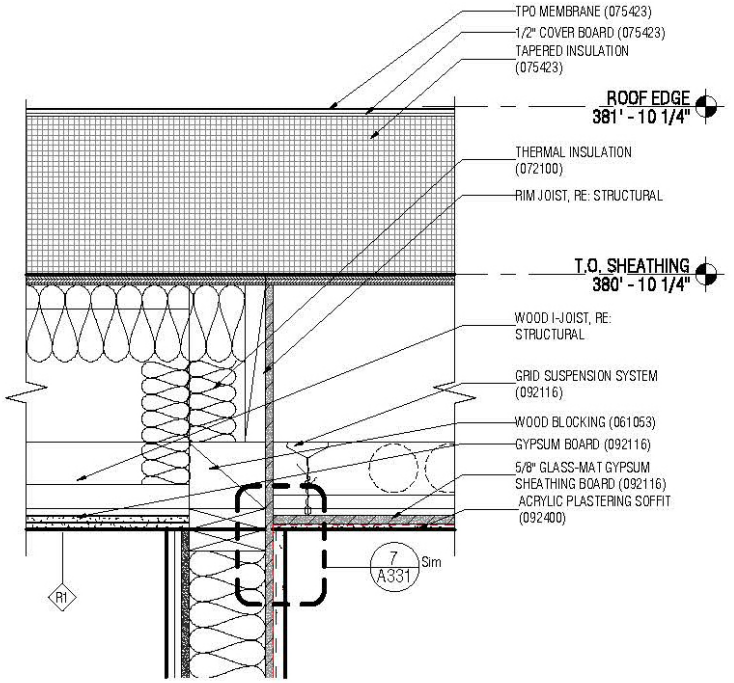
From West

Design Strategies - Zero Carbon (Operation) and Energy-Efficiency

- Building Envelope — Insulation and Windows



Windows: U=0.27



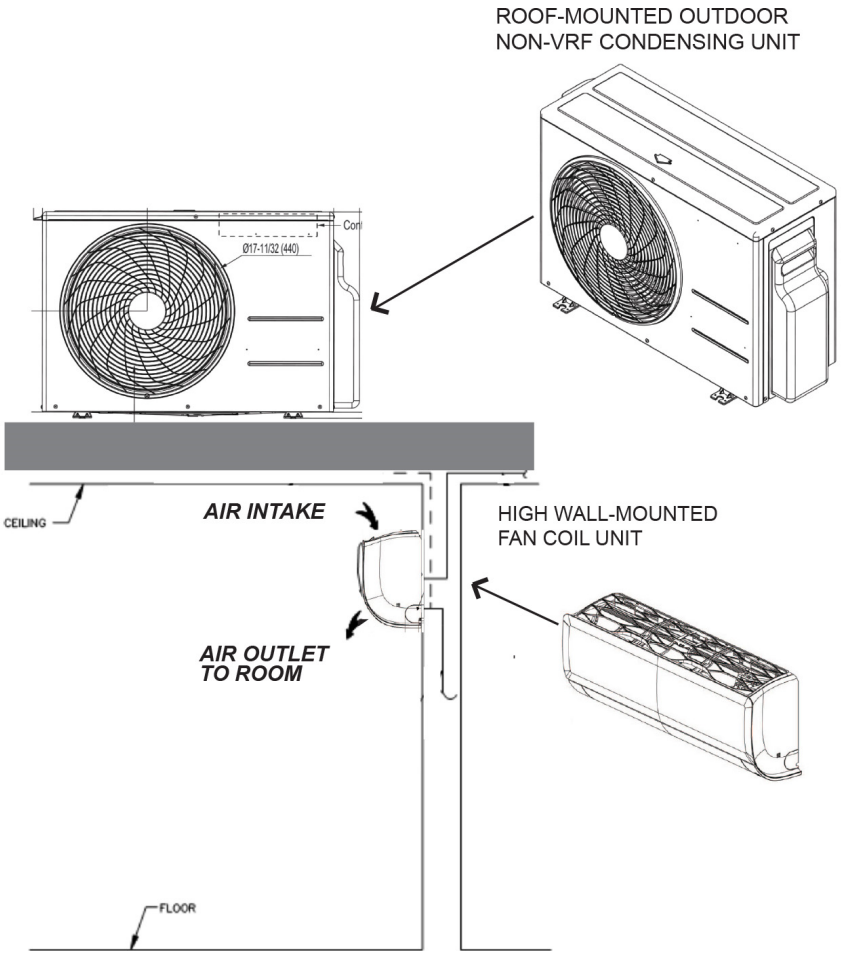
Interior **Exterior**

- Walls: R-21
- Roof: R-30

Design Strategies - Zero Carbon (Operation) and Energy-Efficiency

- Heating, Ventilating and Cooling Systems

Apartments:
Ductless mini-split system with VRF

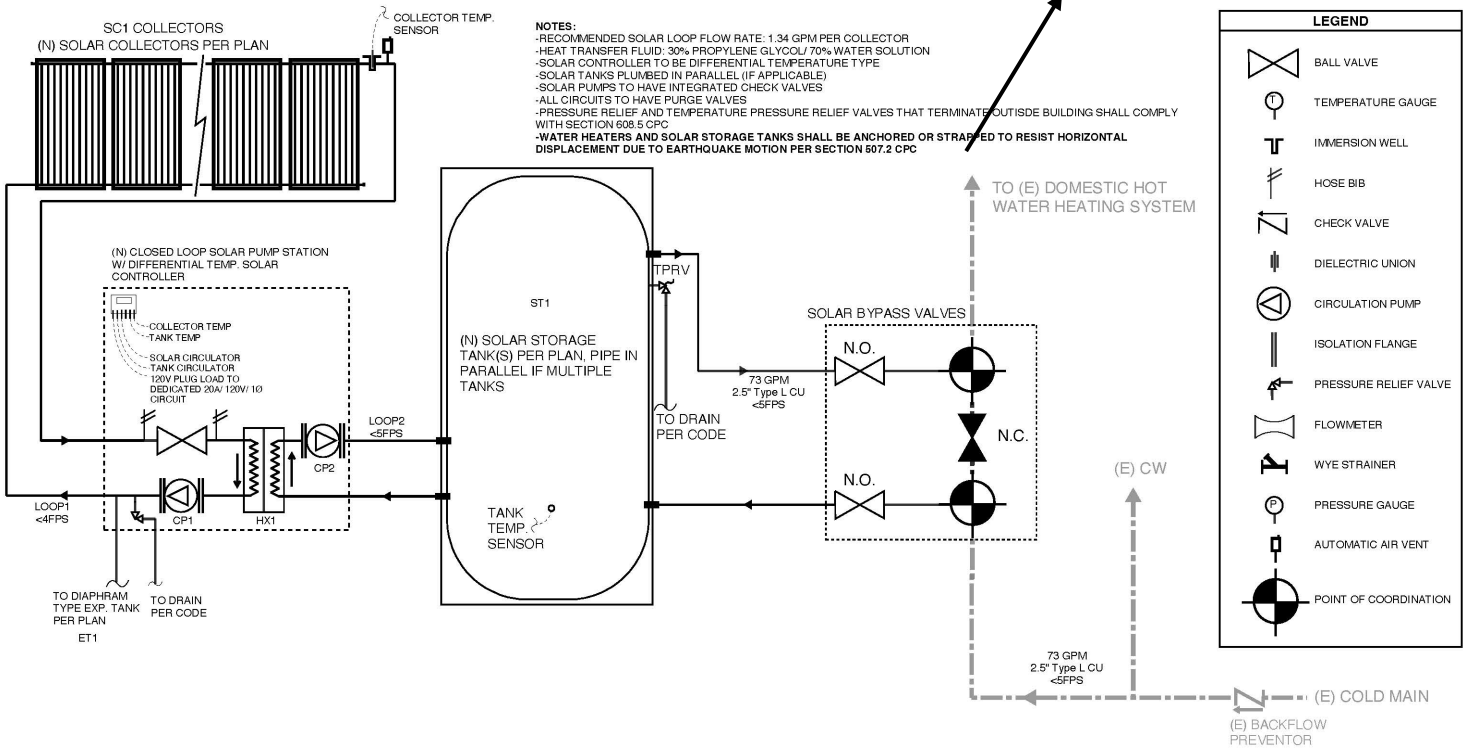


Remaining Spaces:
Ducted-air heat pump system

Design Strategies - Zero Carbon (Operation) and Energy-Efficiency

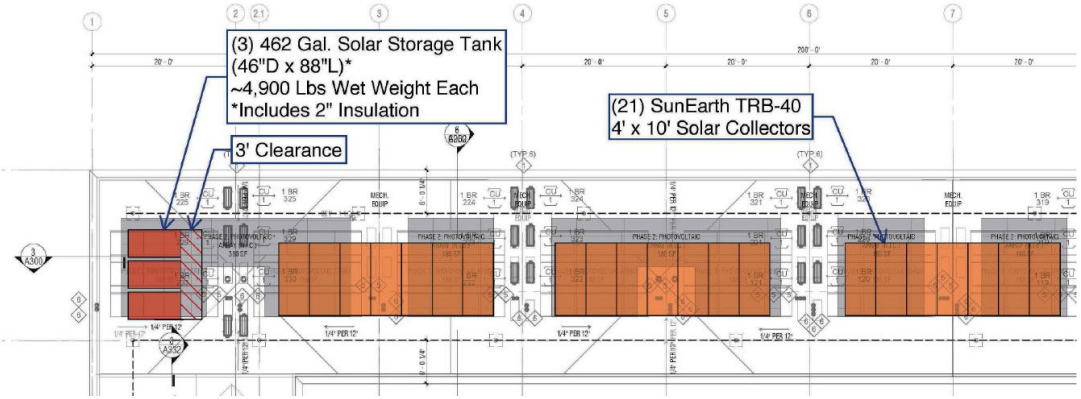
- DHW System

  Central Heat Pump Water Heater (HPWH)

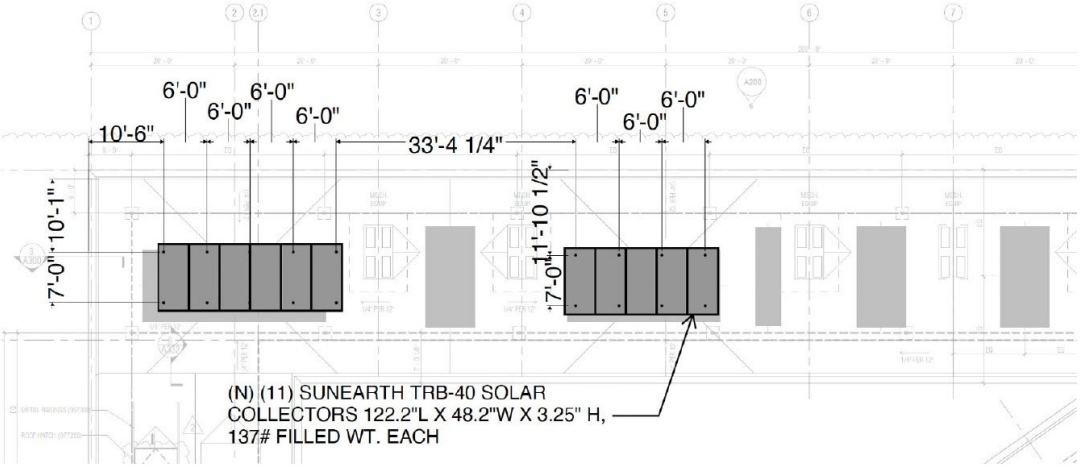


Renewable Energy Sources

- Solar Thermal System

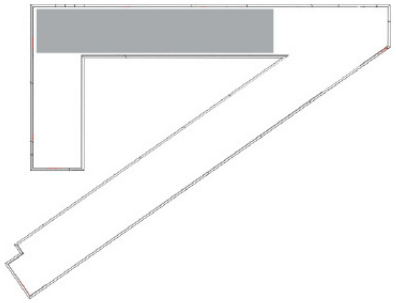


PRELIMINARY DESIGN

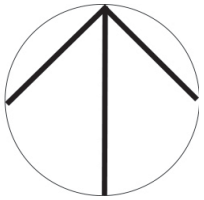


FINAL DESIGN (AS BUILT)

- 11 SunEarth TRB-40 solar thermal panels (4’ x 10’)

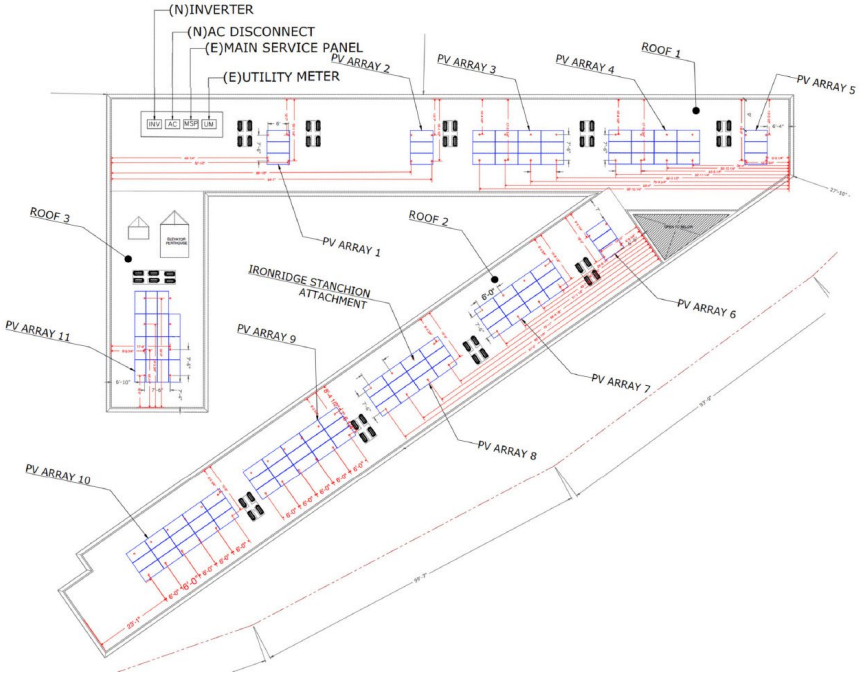


KEY: PLAN LOCATION - SOLAR THERMAL PANELS



Renewable Energy Sources

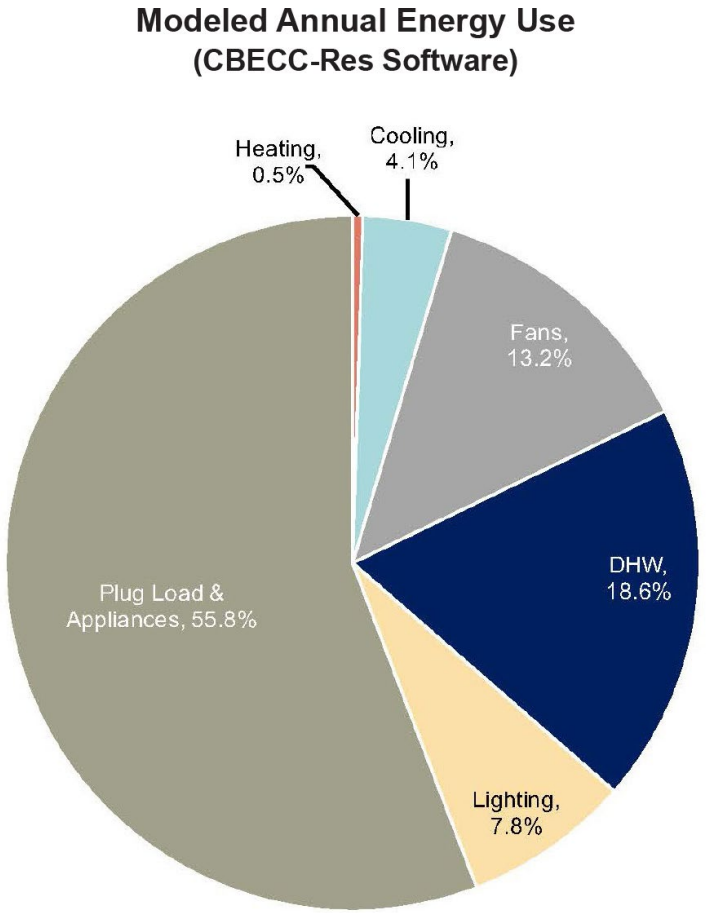
- On-Site Solar Photovoltaic Systems



- 105 Trina Commercial panels, Duomax Twin (410w), 43.1 kW(DC) total

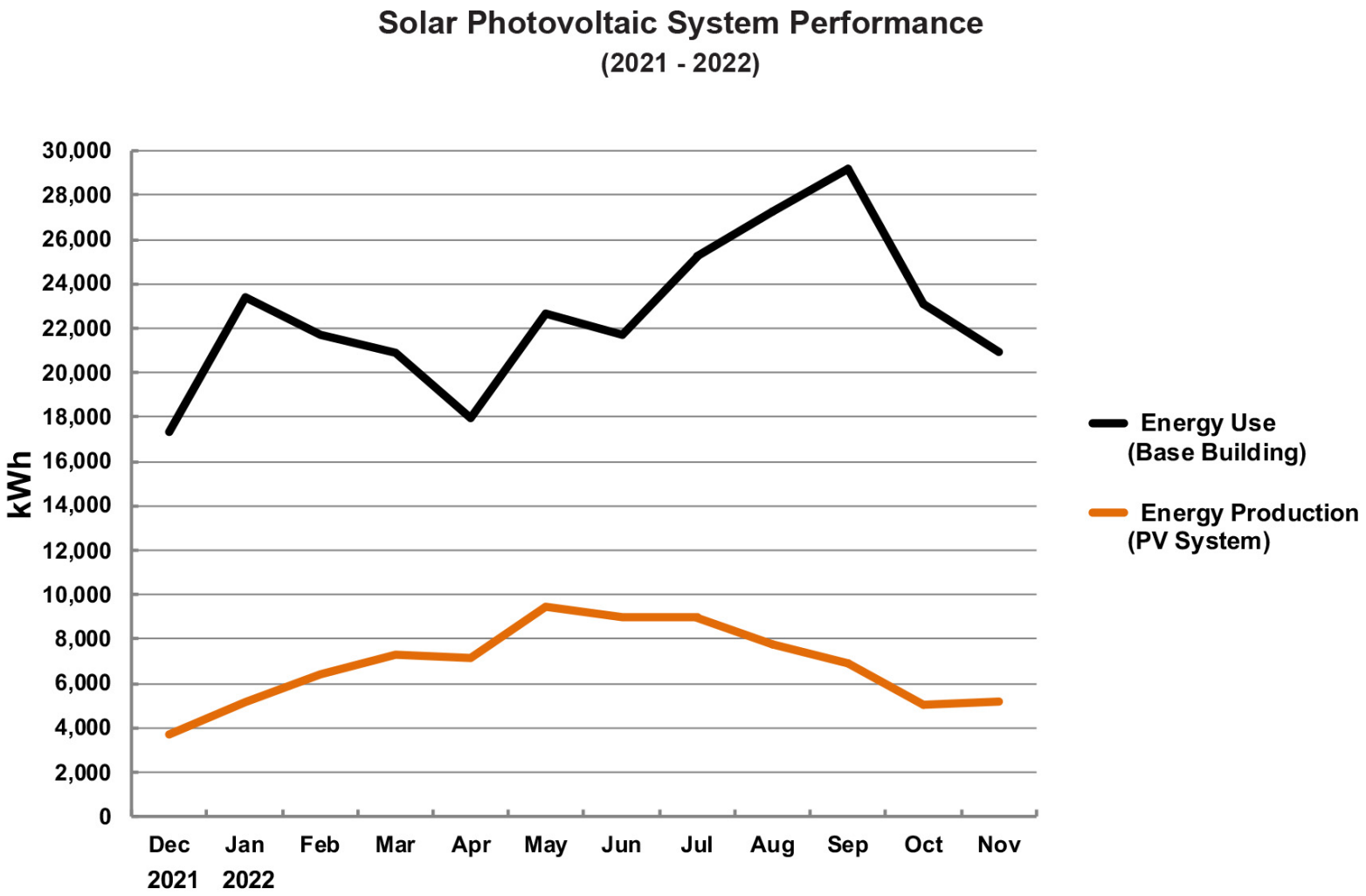
Measured Energy Performance

- Modeled and Measured Monthly Electric Energy Use



- Modeled EUI: 22.0 (kBtu/sf-year)
- Measured EUI: 24.4 (kBtu/sf-year)

Measured Energy Performance



Post-Occupancy Observations and Evaluation

- Client satisfied with all-electric characteristics of project—cost effective in terms of first cost and operating/maintenance costs
- No planning was done for future installation of batteries for electrical load management
- EV-charging infrastructure built into parking lot for future installation of car charging stations
- Embodied carbon analysis not done because good analytical tool were not available in 2018.

Case Study No. 2 — Vera Cruz Village (Renovation)

Richgrove – Central Valley

2

Project Background

- *The User:*

Low-Income Farmworkers

- *The Client:*

Self-Help Enterprises
(Non-Profit dedicated to building and managing housing in disadvantaged communities in the Central Valley)

- *Project Goals — Zero Carbon (Operation) and Energy-Efficiency:*

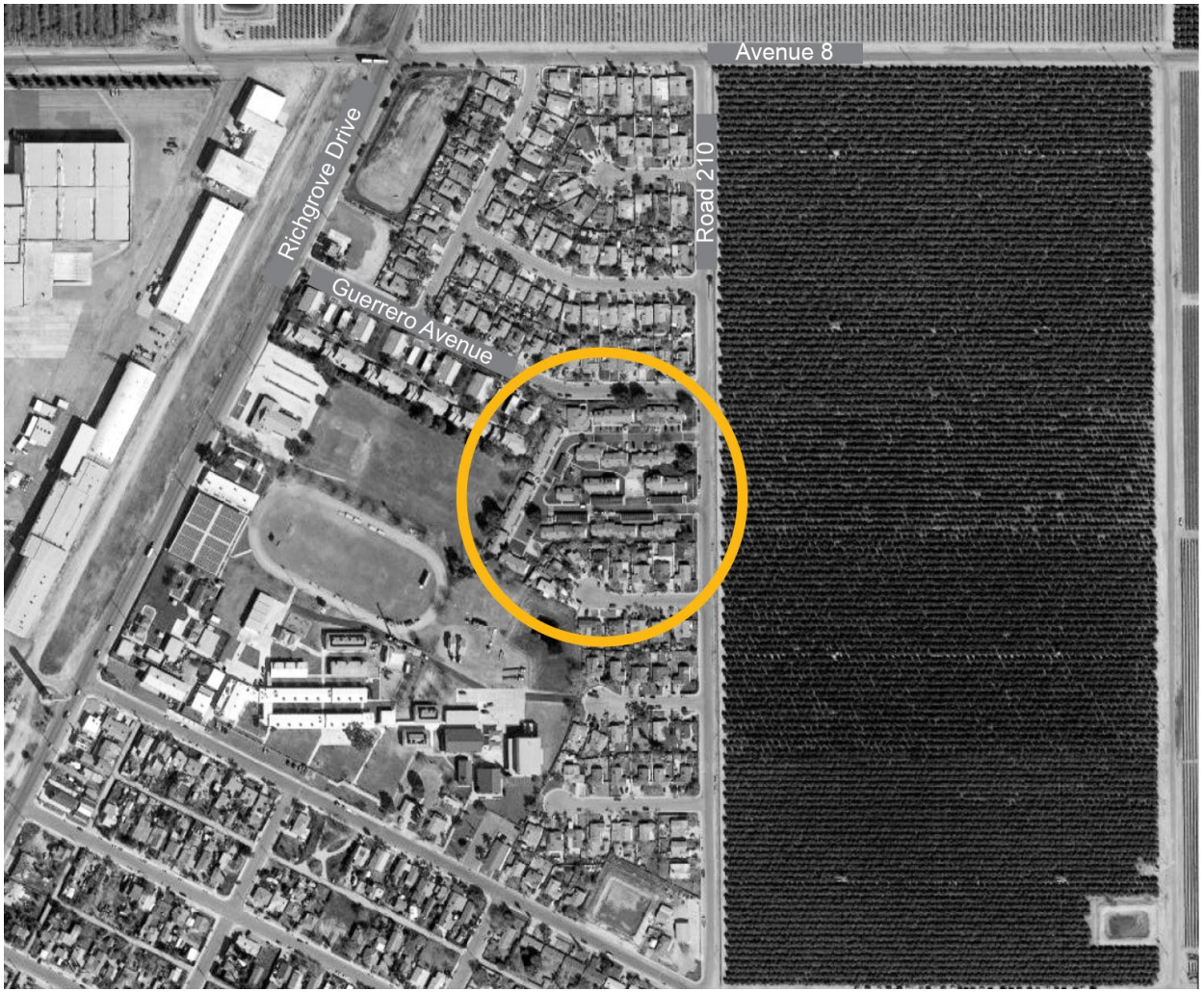
1. Study and implement all-electric retrofit of existing affordable housing for minimum cost where occupants remain in the units.
2. Study industrialized retrofit packages that can be rapidly deployed on existing affordable housing undergoing all-electric retrofit.

- *The Building Program:*

Retrofit 49 units of existing housing: utilizing rapid deployment approach on 8 units and standard retrofit approach on 41 units.

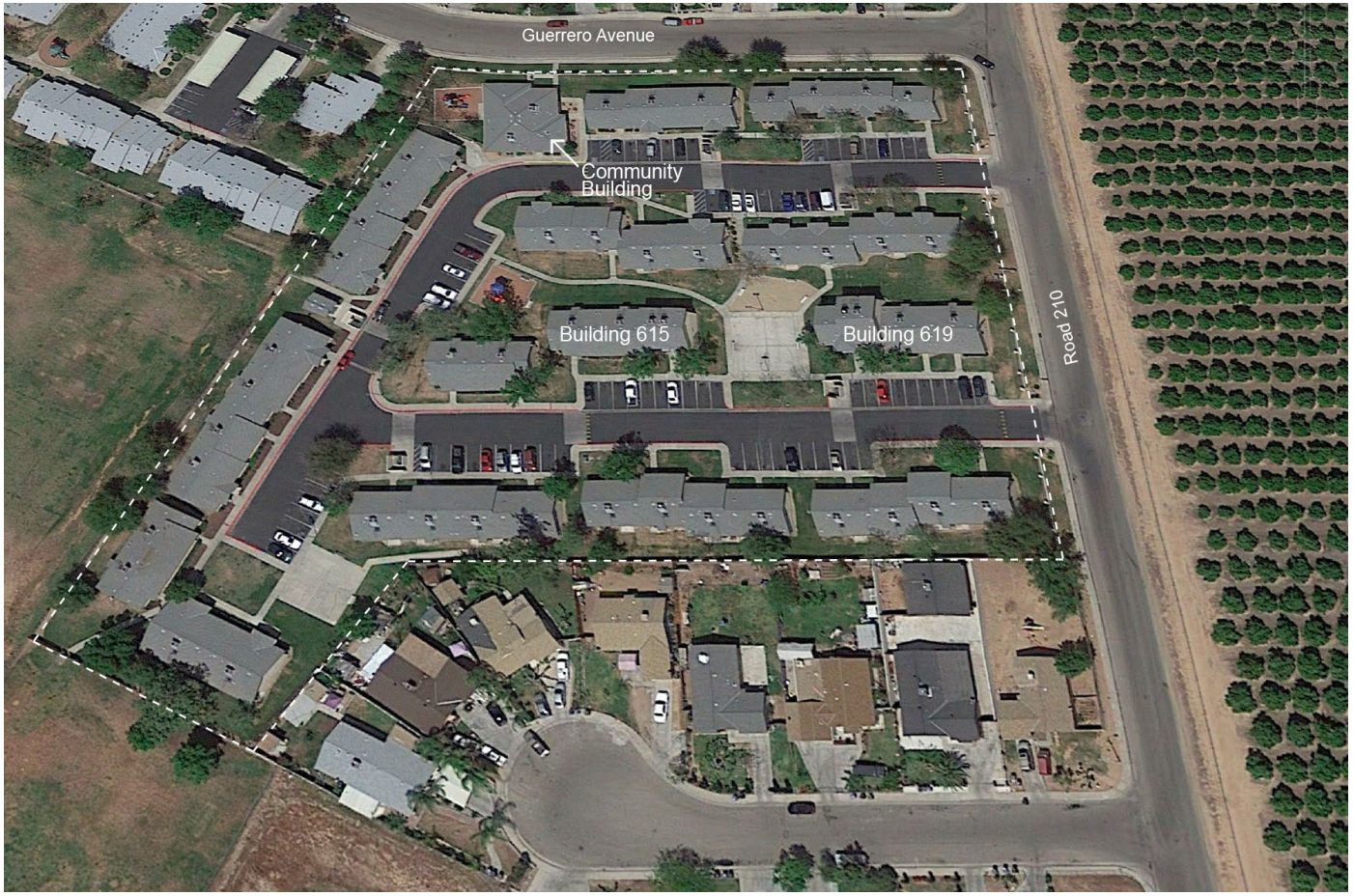
Project Background

- Site Vicinity



Project Background

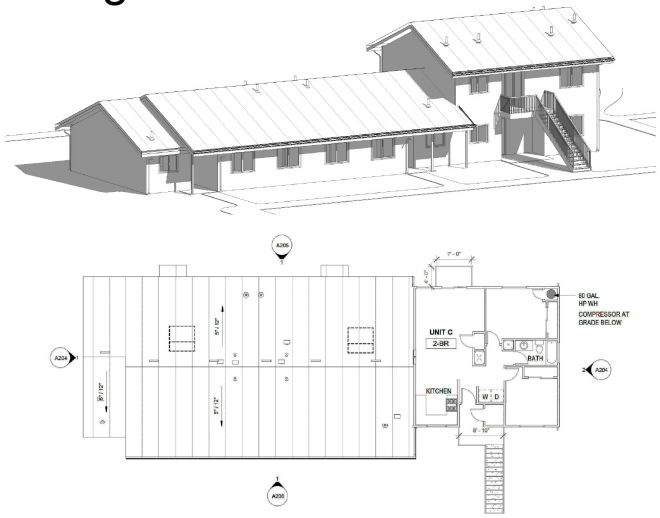
- Site Plan



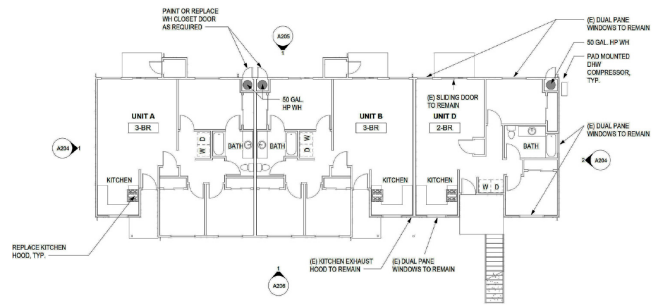
Project Background

- Selected for Rapid Deployment Research Study

Building 615



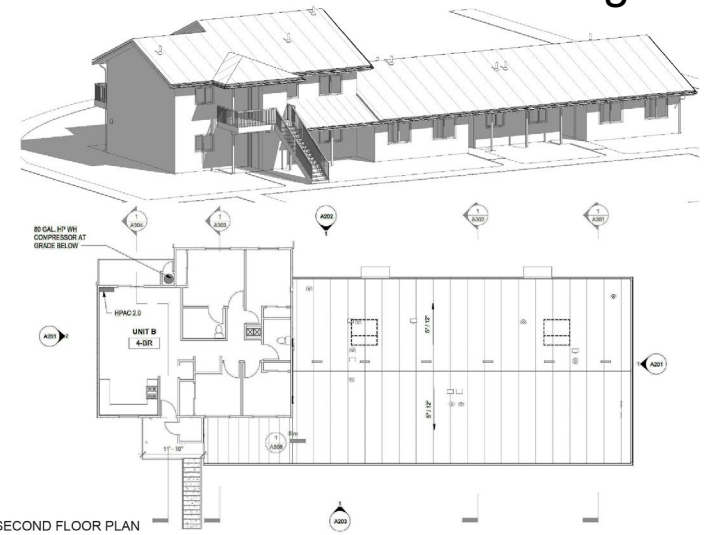
SECOND FLOOR PLAN



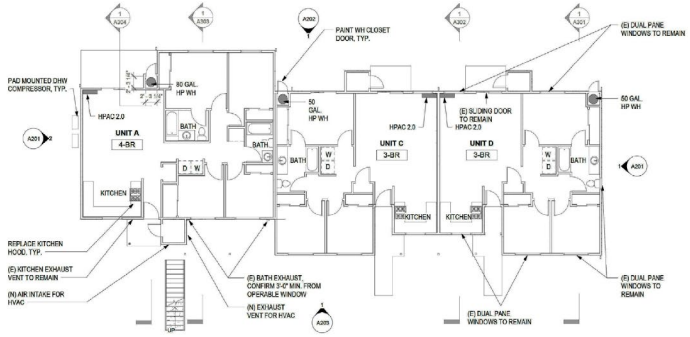
FIRST FLOOR PLAN

0 5 10 20 40 FT

Building 619



SECOND FLOOR PLAN

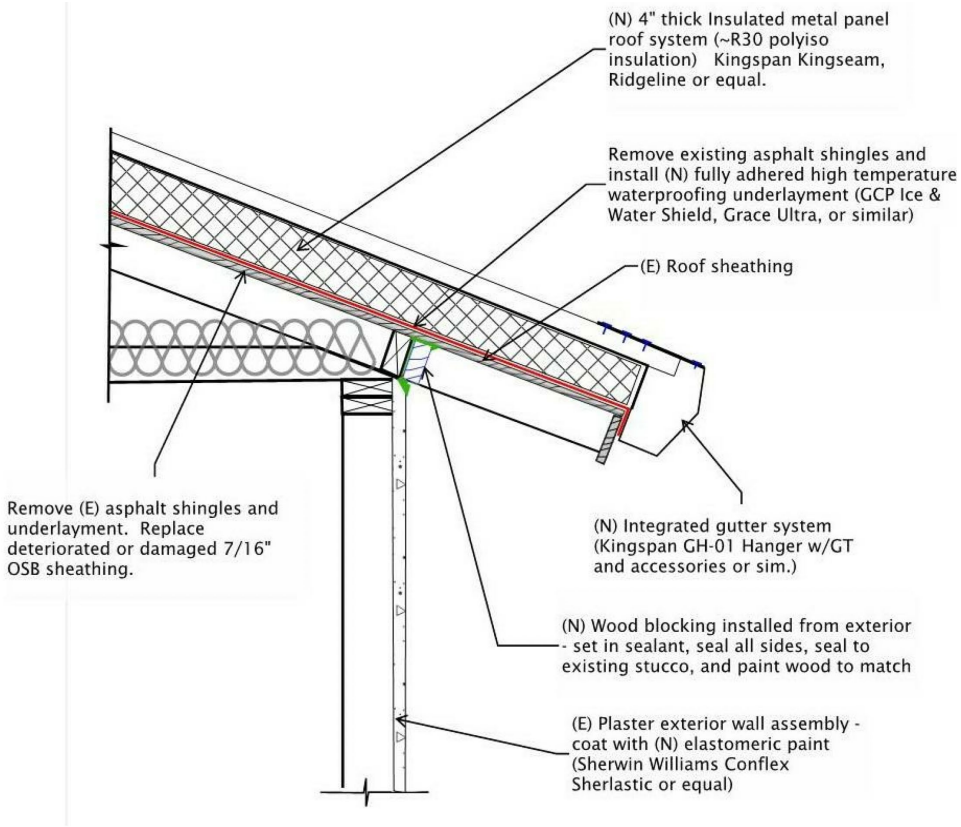


FIRST FLOOR PLAN

Design Strategies - Zero Carbon (Operation) and Energy-Efficiency

- Building Envelope—Roof Insulation

Rapid Deployment Research Study



- R-30 polyiso insulation in panels

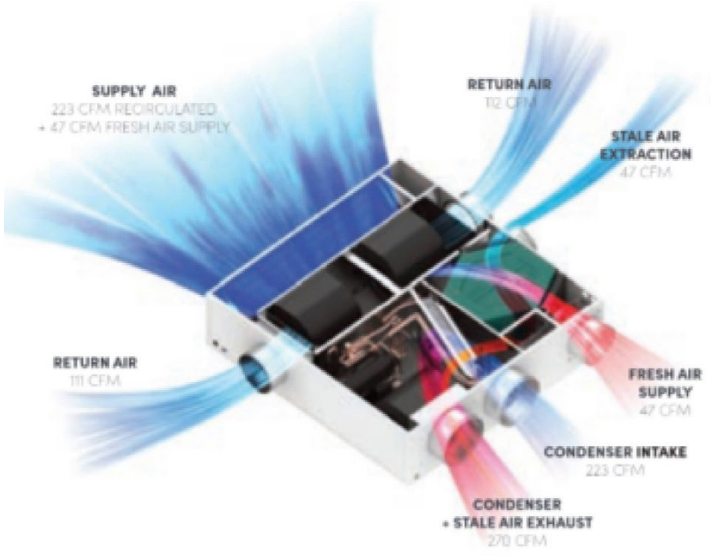
Design Strategies - Zero Carbon (Operation) and Energy-Efficiency

- Building Envelope — Windows and Walls
  - No insulation retrofit of any existing walls because units were occupied
  - Window replacement with double-glazed units only – all units
- Building Envelope — Airtightness
  - All units sealed at attic only because units were occupied
  - Three types of sealing methods used for evaluation purposes
  - Blower-door test done for one building using each type of sealing method
  - Results:

Before attic sealing:	8.0 ACH50
Standard foam sealing:	6.8 ACH50
Aerosol sealing:	3.7 ACH50

Design Strategies - Zero Carbon (Operation) and Energy-Efficiency

- Heating Systems
  - All Apartments - Rooftop gas furnaces and DX cooling package units replaced by ducted-air heat pumps
  - Rapid Deployment Research Study – Energy Recovery Ventilator (ERV) installed in Building 619

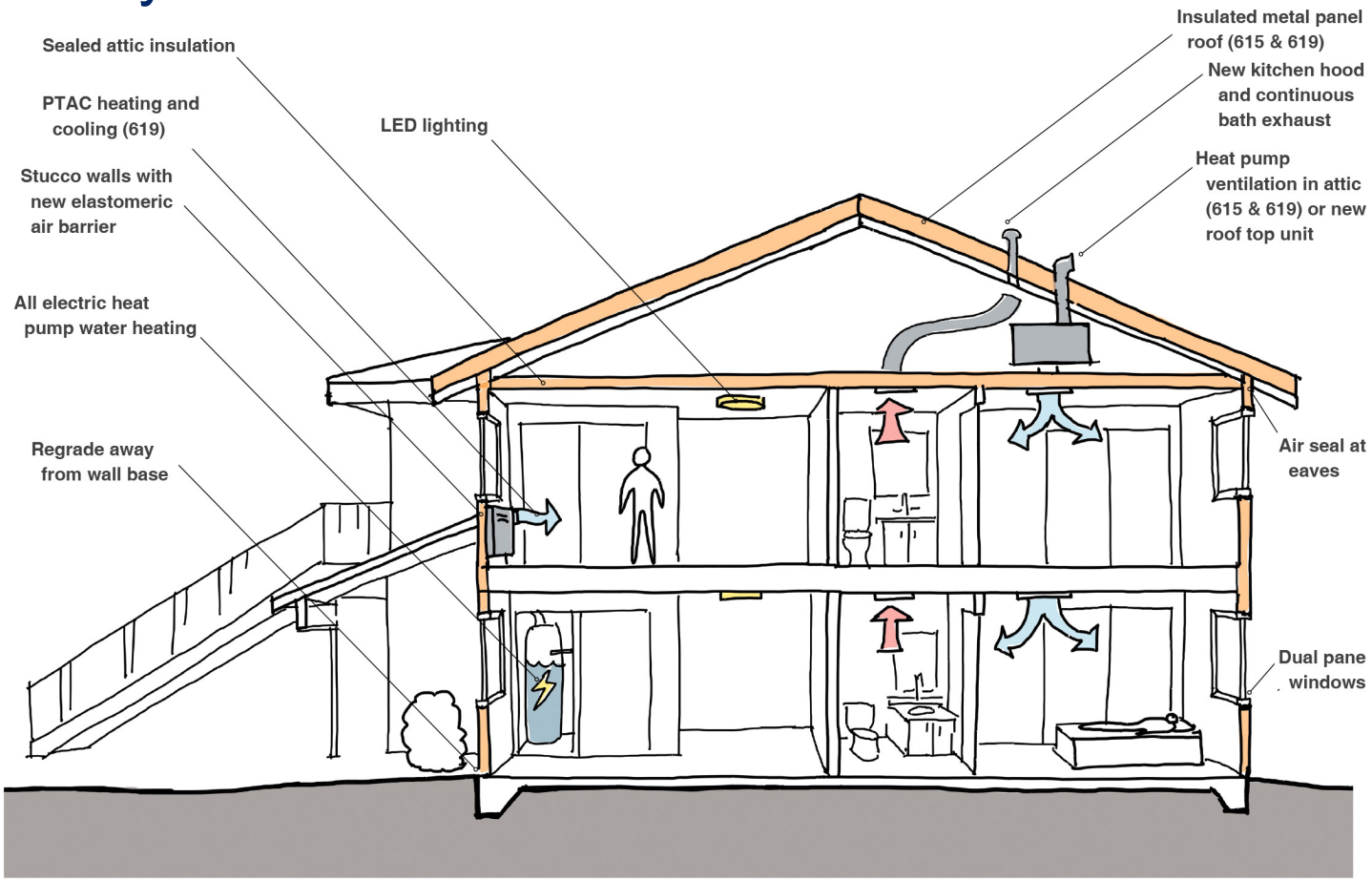


Design Strategies - Zero Carbon (Operation) and Energy-Efficiency

- DHW Systems
  - All Apartments – Gas-fired water heaters replaced by Heat Pump Water Heaters (HPWH) in exterior closets
  - Rapid Deployment Research Study – Three apartments received test installation of higher efficiency HPWH

Design Strategies - Zero Carbon (Operation) and Energy-Efficiency

- Summary Retrofit Measures



Renewable Energy Sources

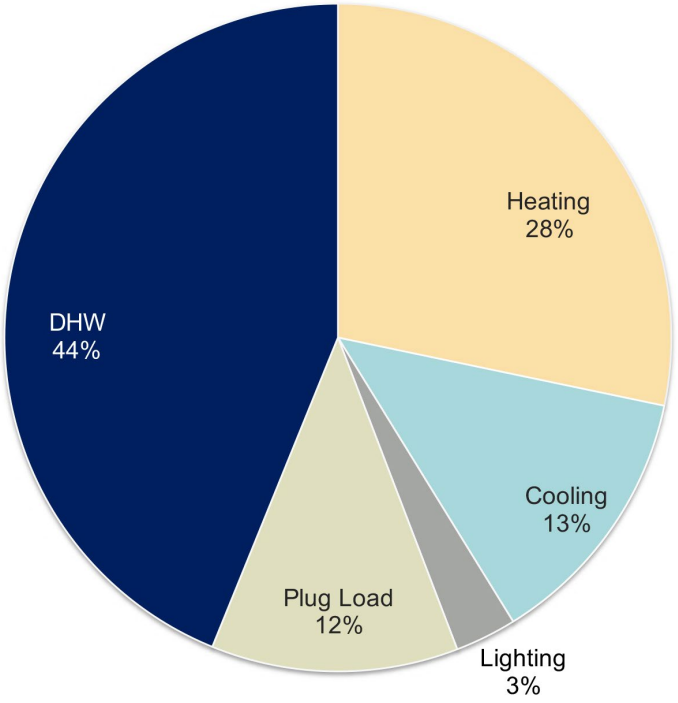
- On-Site Solar Photovoltaic Systems

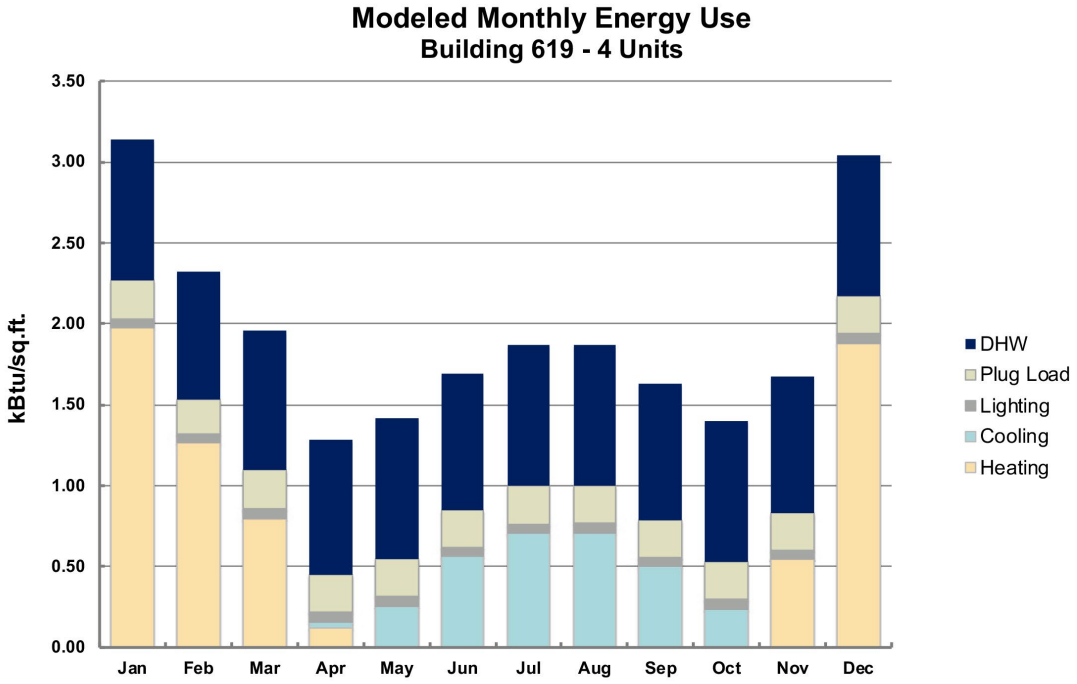
- 384 panels on parking canopies – 138 kW total
- Third-party PPA for solar PV system installation, management and maintenance
- 2022 PV energy production: 151,000 KWh, 35% of total energy used

Measured Energy Performance

- Modeled Monthly Electric Energy Use

  Rapid Deployment Research Study – Building 619

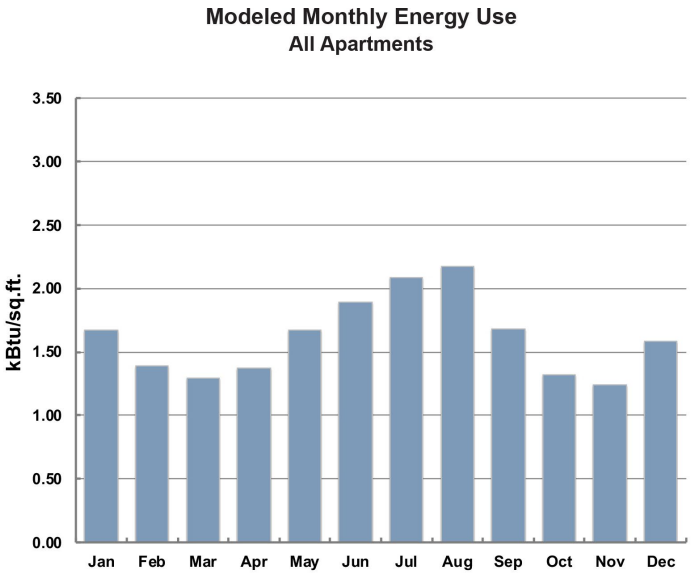


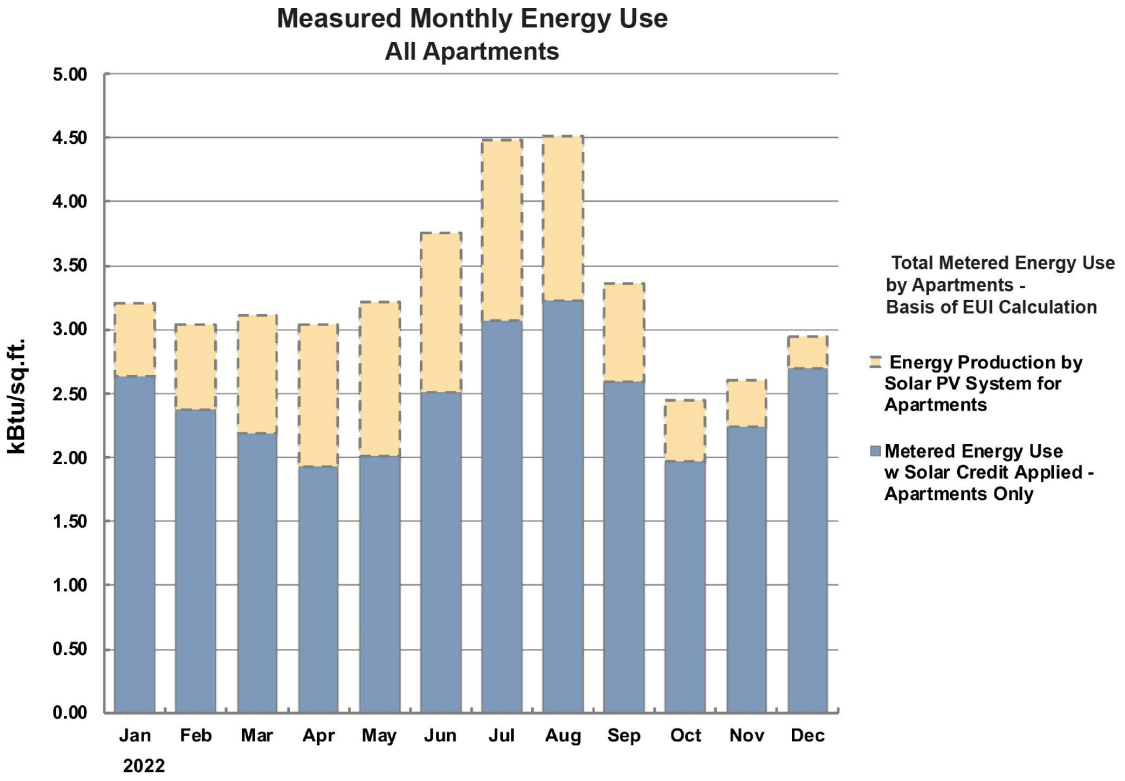


- Modeled EUI: 18.4 kBtu/gsf-year

Measured Energy Performance

- Measured Monthly Electric Energy Use
  All Apartments





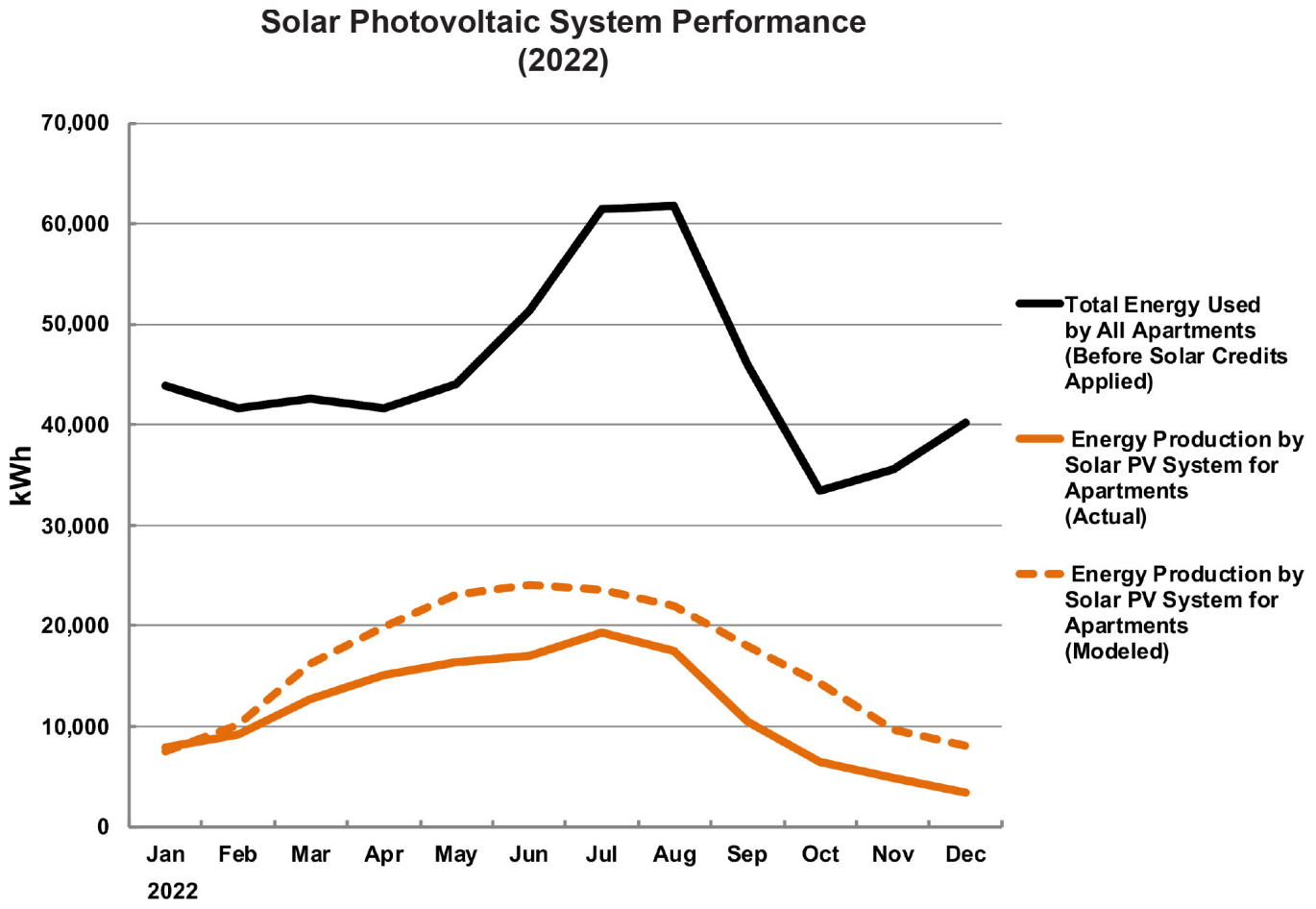
Modeled EUI: 19.4 kBtu/sf-year

Measured EUI: 39.7 kBtu/sf-year

Measured Energy Performance

- Measured Monthly Electric Energy Use and Monthly Solar PV System Production

  All Apartments



Post-Occupancy Observations and Evaluation

- Successfully completed all-electric retrofit while occupied
- Extra coordination required with general contractor when planning the work for occupied apartments
- Research objectives of Rapid Deployment Research Study still being evaluated—non-mainstream technologies did offer advantages in installation and performance improvements

Case Study No. 3 — 2060 Folsom (New)

San Francisco

3

Project Background

- *The User:*

Low-income families (40% to 60% AMI) and Transitional-Aged Youth (TAY) in the Mission District of San Francisco

- *The Client:*

Mission Economic Development Agency (MEDA) and Chinatown Community Development Center (CCDC)

- *Project Goals — Zero Carbon and Sustainability:*

Established at *Green Charette*, all-electric zero-carbon operation and minimum embodied carbon total

- *The Building Program:*

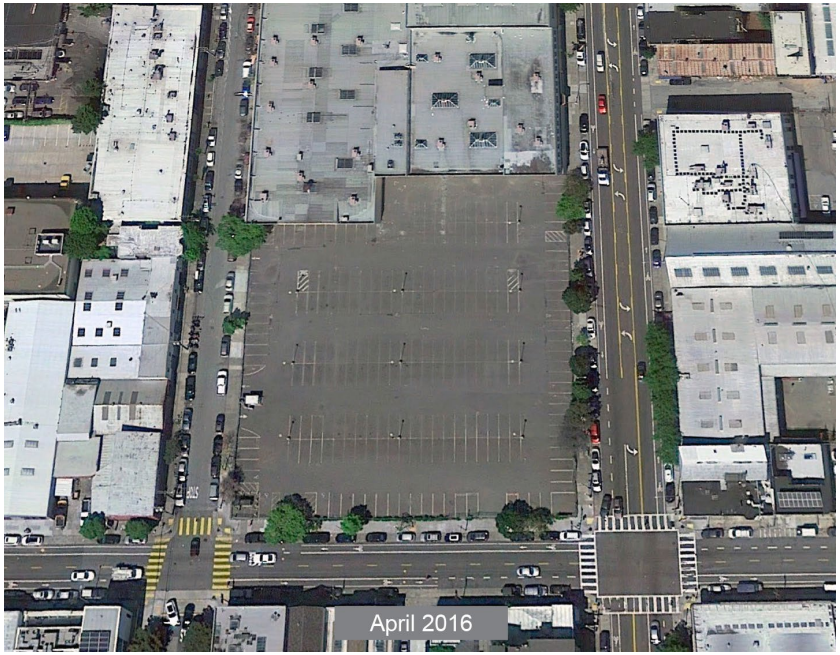
127 1BR, 2BR and 3BR apartments, social services and community spaces, childcare center, community meeting room and neighborhood café.

Project Background

- Site Vicinity

Project Background

- Site Development



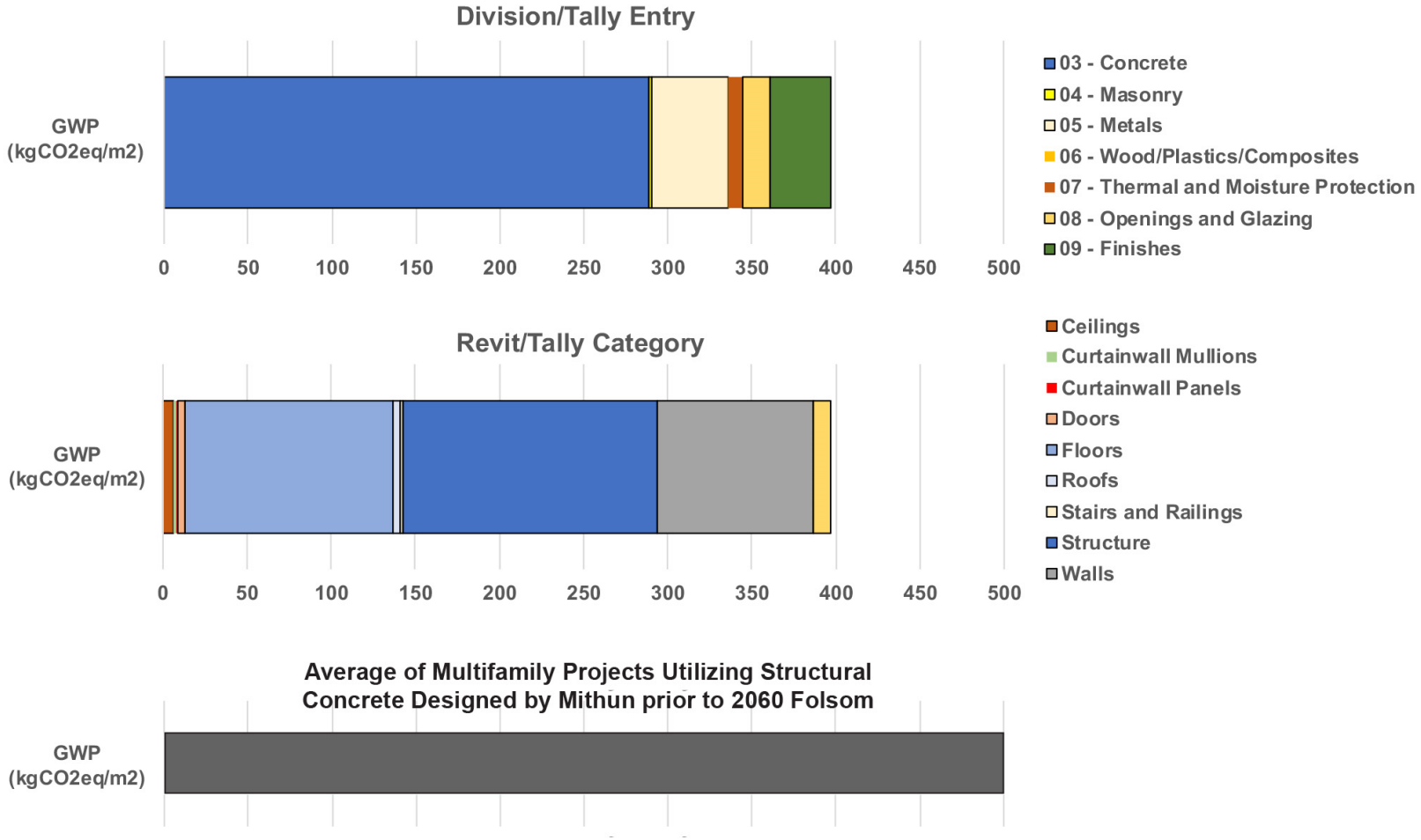
Park completed in 2017
Building completed in 2020

Design Strategies – Minimize Embodied Carbon

- Embodied Carbon Assessment
  - Extensive concrete foundations required was motivation to minimize the embodied carbon overall
  - Embodied carbon analysis done for every building material and product using Life Cycle Analysis (LCA) in Revit (*Tally* sub-program)
  - Result: Materials and product specifications selected that minimized embodied carbon
  - Embodied Carbon rating number = *GWP ("Global Warming Potential")*
    Unit of GWP: 1 $kgCO_2eq/m^2$

Design Strategies – Minimize Embodied Carbon

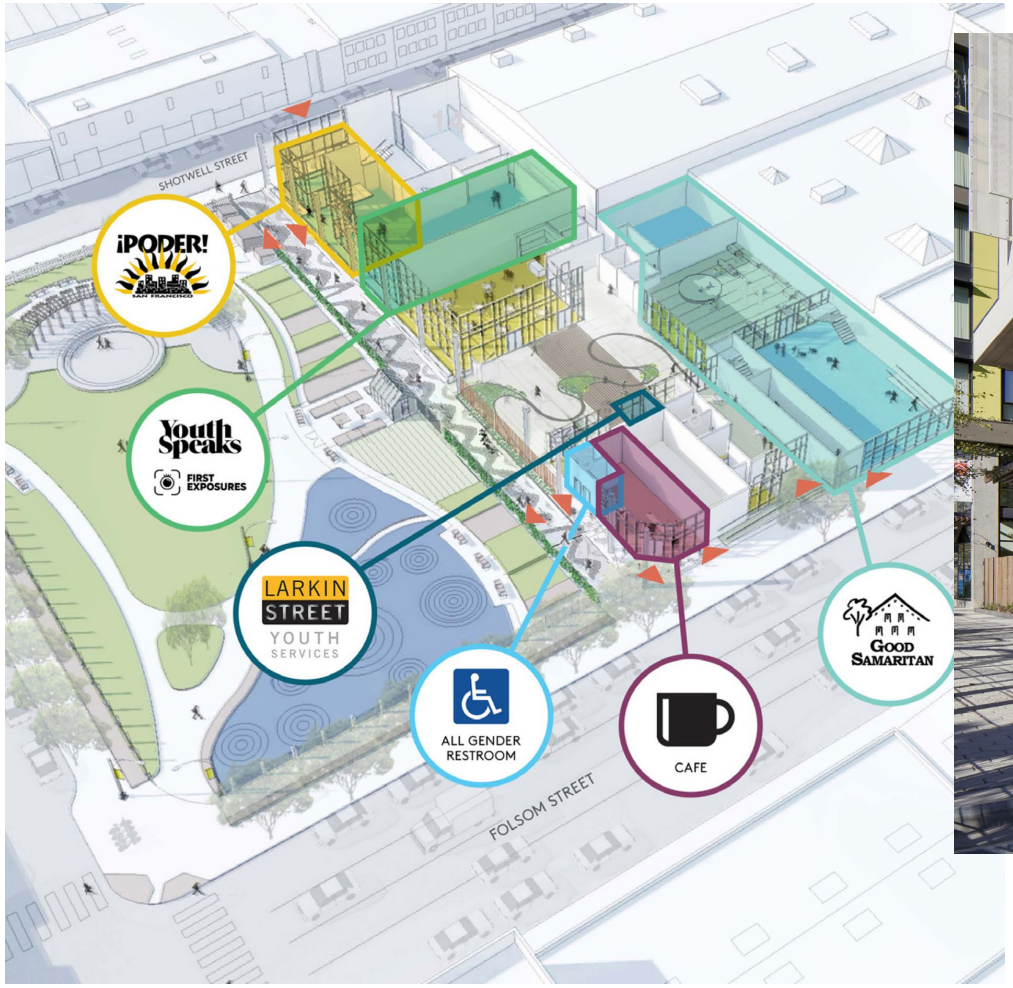
- Embodied Carbon Assessment



GWP rating of 2060 Folsom building = 397 ($kgCO_2eq/m^2$)

Design Strategies - Zero Carbon (Operation) and Energy-Efficiency

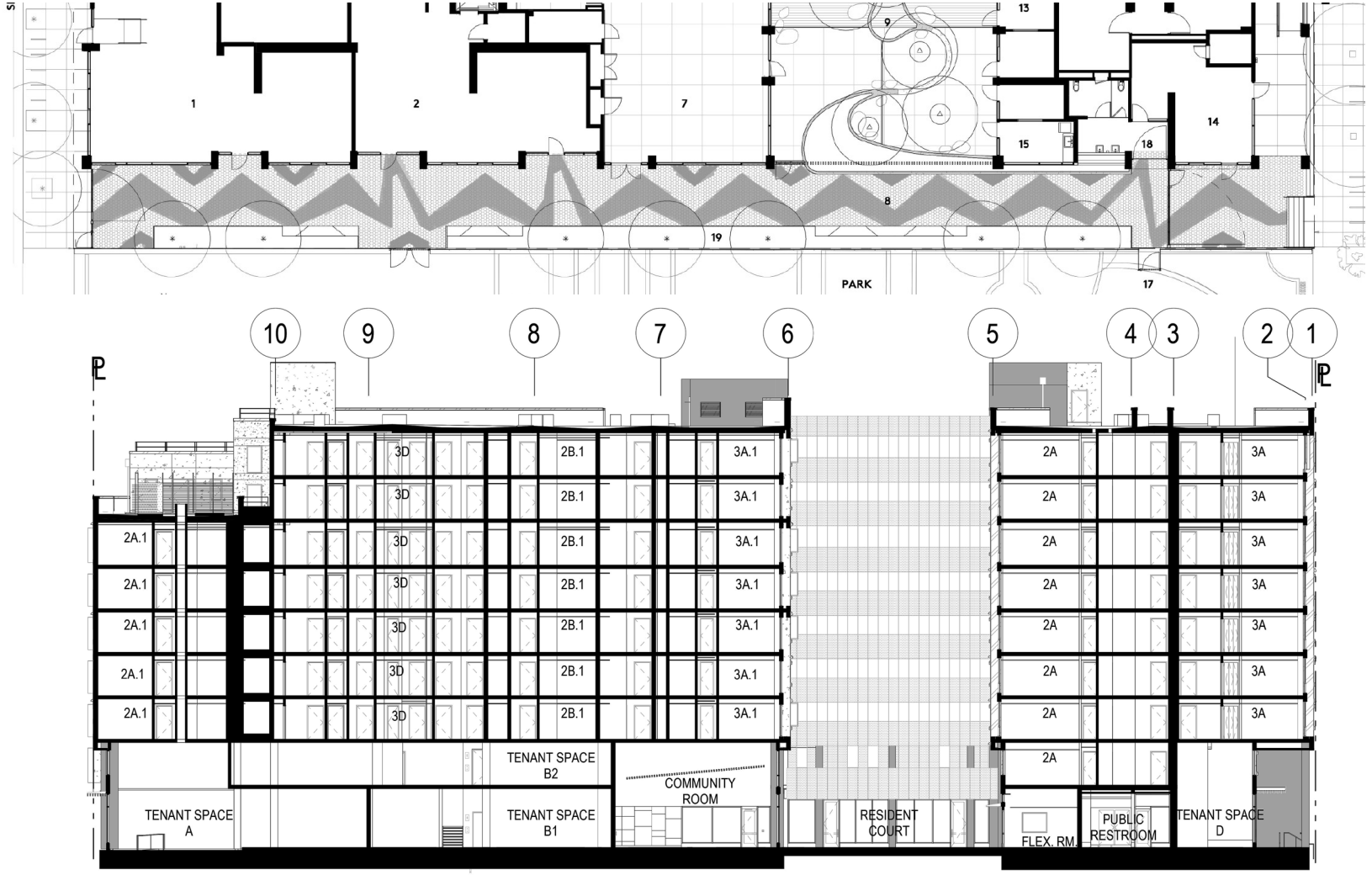
- Program Accommodation



- No Parking Required

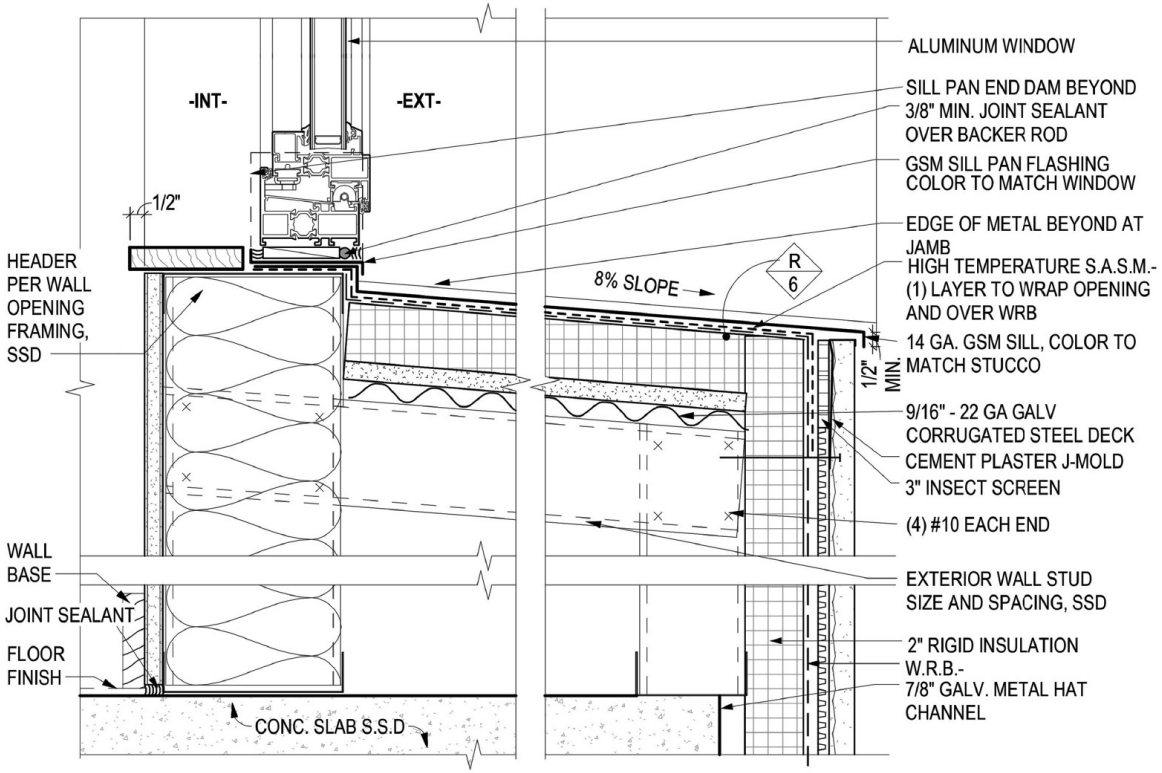
Design Strategies - Zero Carbon (Operation) and Energy-Efficiency

- Program Accommodation



Design Strategies - Zero Carbon (Operation) and Energy-Efficiency

- Building Envelope — Insulation



WALLS
2x6 with R-19 fiberglass insulation plus 2” rigid polyiso outside metal studs to prevent thermal bridging

ROOF
R-30 insulating cellular concrete

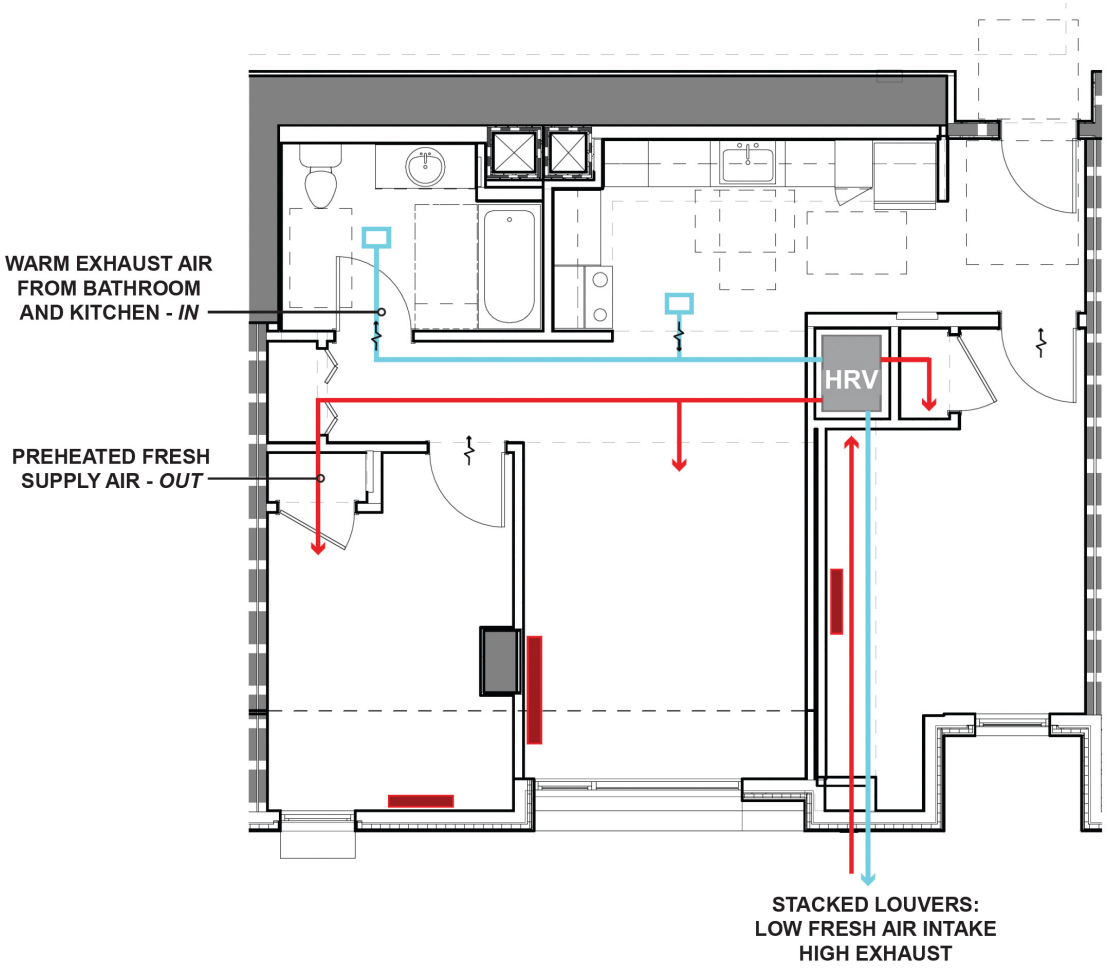
GROUND FLOOR SLAB
None

Design Strategies - Zero Carbon (Operation) and Energy-Efficiency

- Heating System - Apartments
  - No Heat Pump!

Benign marine climate and well-insulated envelope = No Mechanical Cooling

  - Heating by electric resistance heaters located in ceiling coves
  - Fresh air and cooling by *Heat Recovery Ventilator (HRV)*
  - No central system and no ductwork beyond each apartment



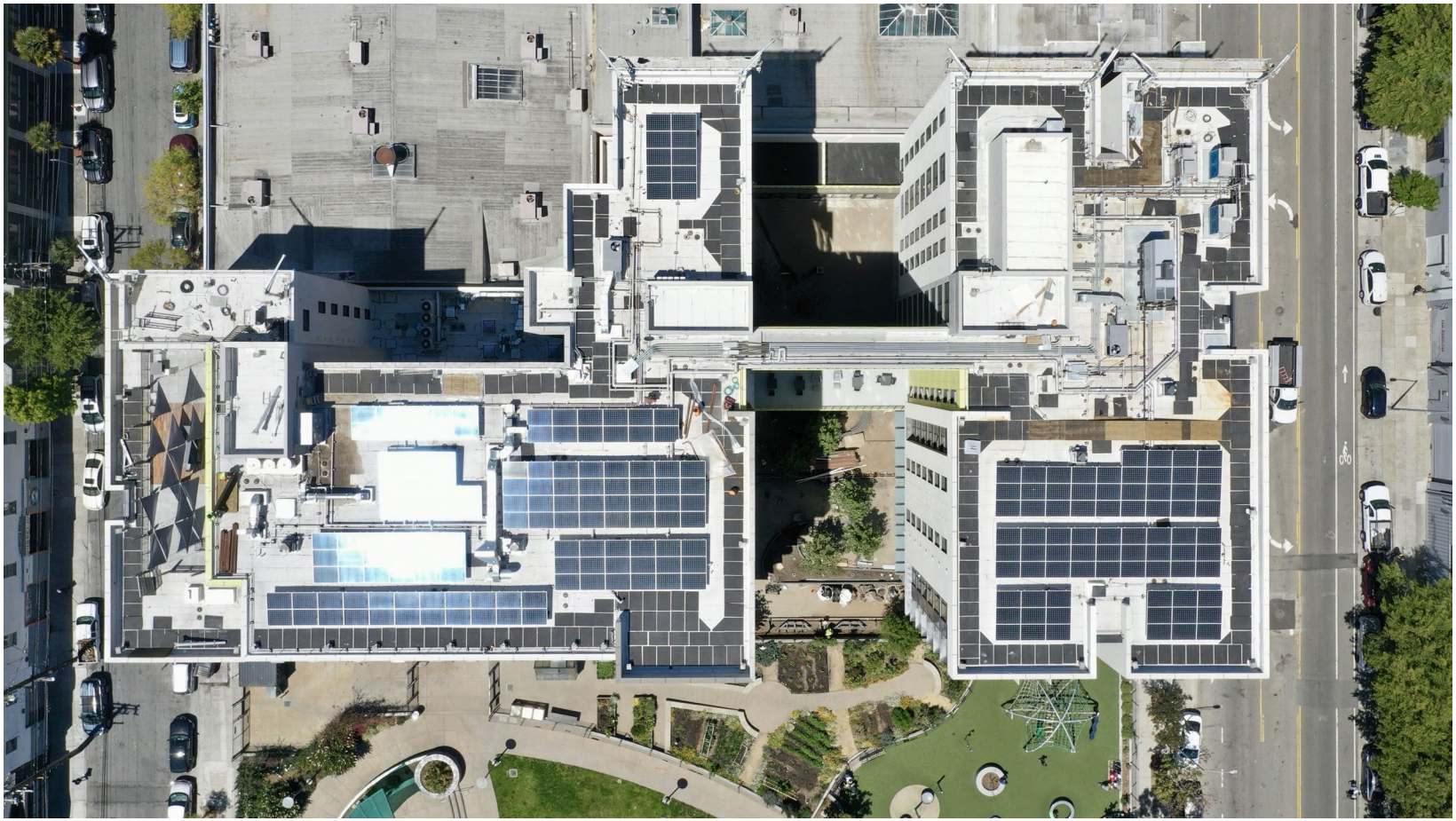
Design Strategies - Zero Carbon (Operation) and Energy-Efficiency

- Heating System – Floors 1 and 2
  - Conventional air-source heat pumps
  - DOAS systems with *Variable Refrigerant Flow (VRF)*

- DHW System
  - Central HPWH system located on the roof

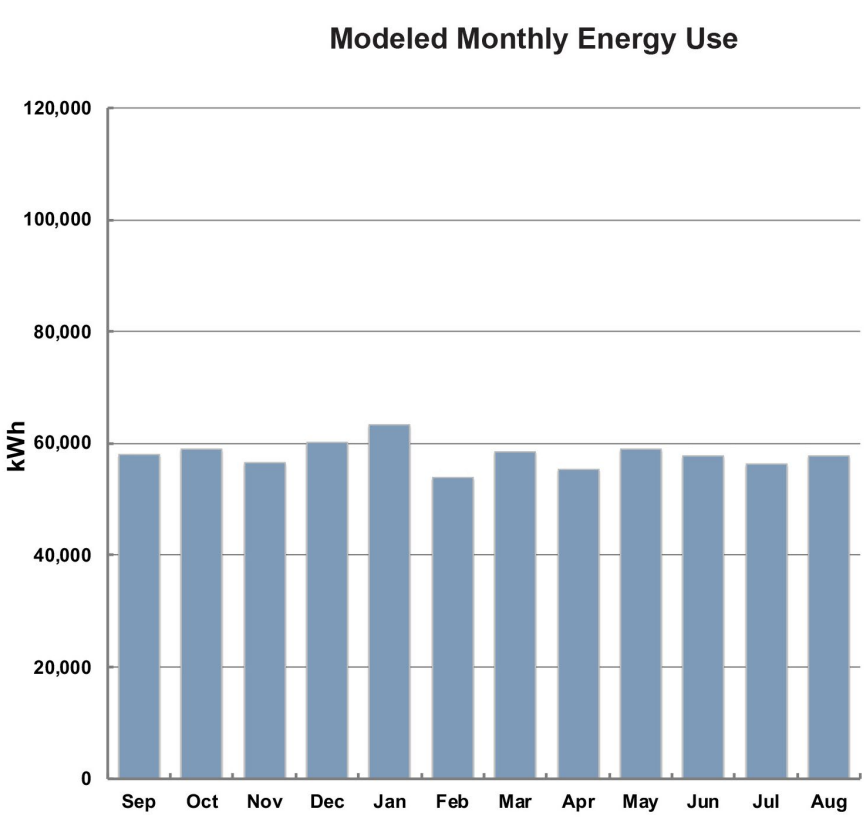
Renewable Energy Sources

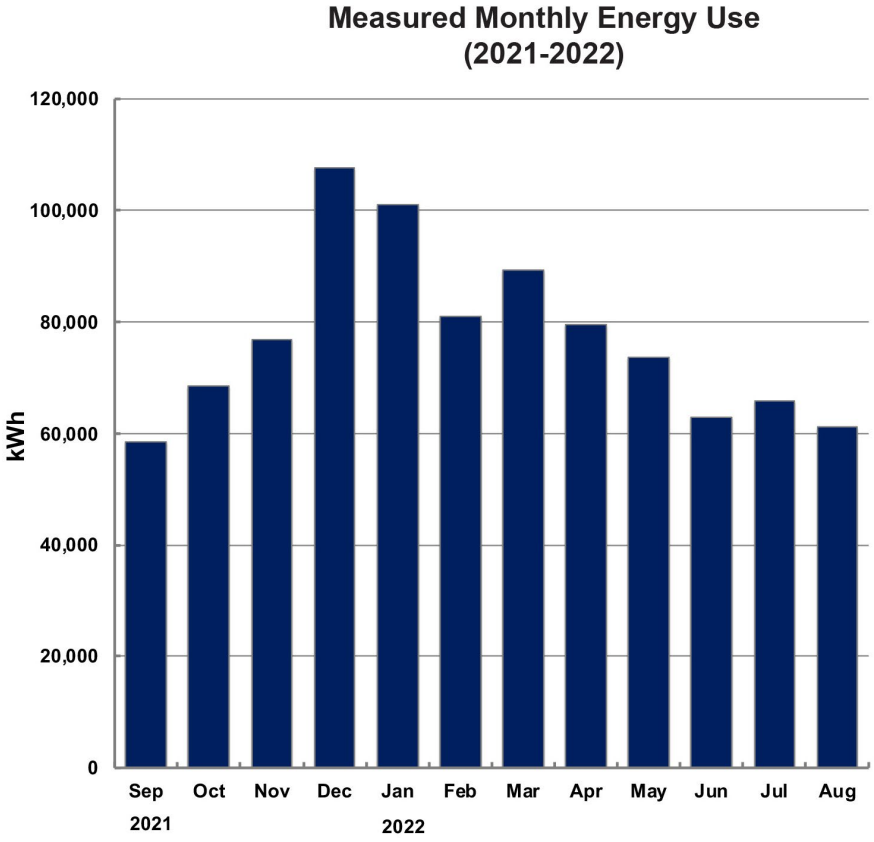
- On-Site Solar Photovoltaic Systems
  - 212 Sunpower panels – 76.3 kW



Measured Energy Performance

- Modeled and Measured Monthly Electric Energy Use



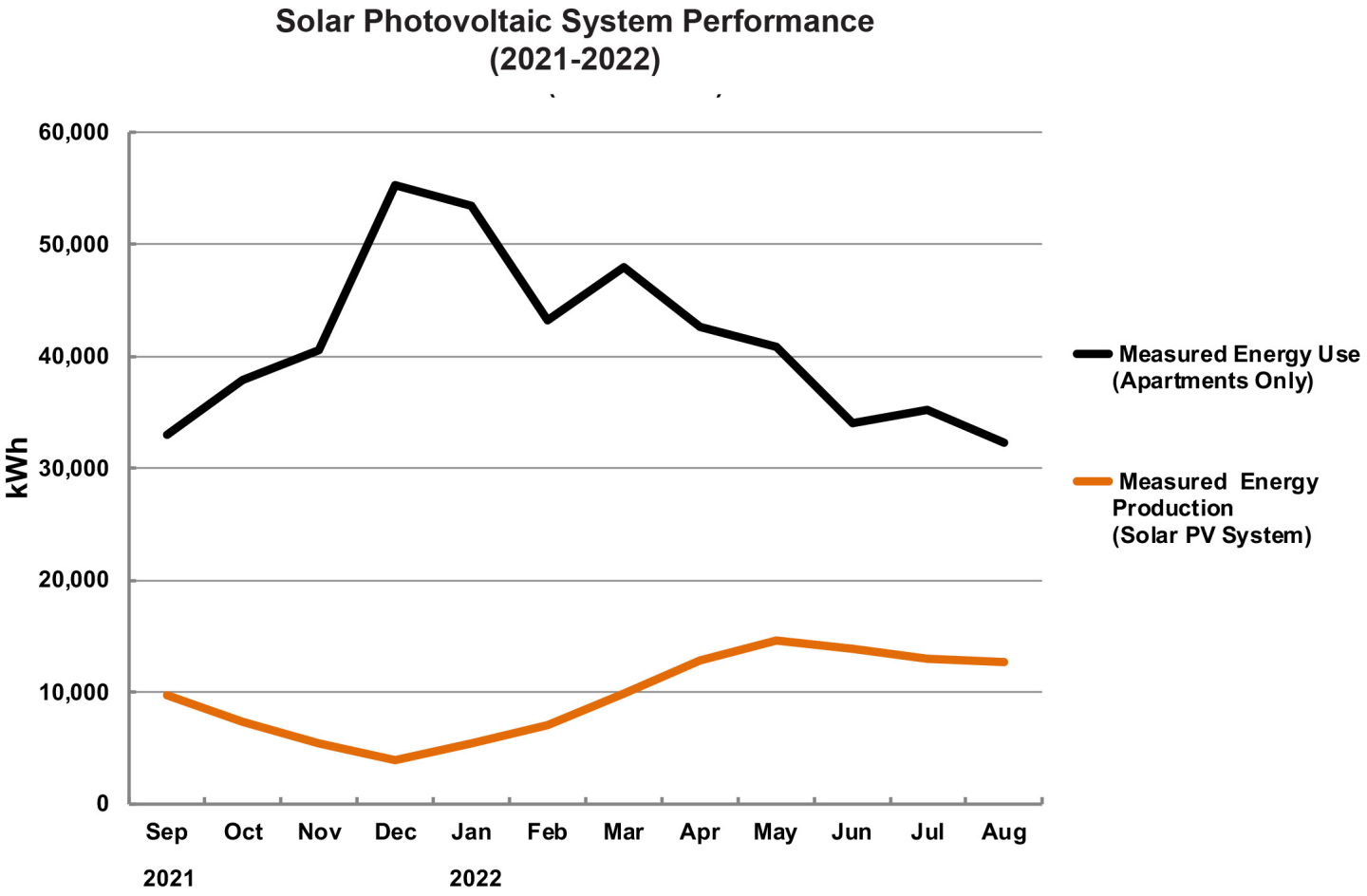


Modeled EUI: 14.0 kBtu/sf-year

Measured EUI: 18.6 kBtu/sf-year

Measured Energy Performance

- Solar PV System Performance (Annual)



Post-Occupancy Observations and Evaluation

- Project Carbon Goals Achieved?
  - Embodied Carbon Assessment: Successful analysis allowed detailed specification of materials and products that minimized the embodied carbon content
  - Power supply from San Francisco's public utility is 100% renewable, so 2060 Folsom is *Zero Carbon* in its operation
- Energy Efficiency also evident from low EUI for this building size and type.

Q&A