





We design thoughtful places
that uplift communities



40 years
13,000+ homes
400+ awards
multifamily experts

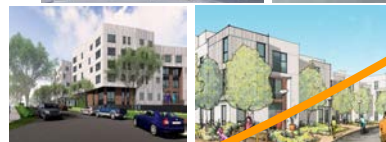


All-Electric Projects

22 (of 29 projects)
On the boards in 2021



8
On the boards in 2019



2
On the boards in 2018



1
Completed in 2018



THE BUILDING DECARBONIZATION PRACTICE GUIDE

A Zero Carbon Future for the
Built Environment

VOLUME 3:

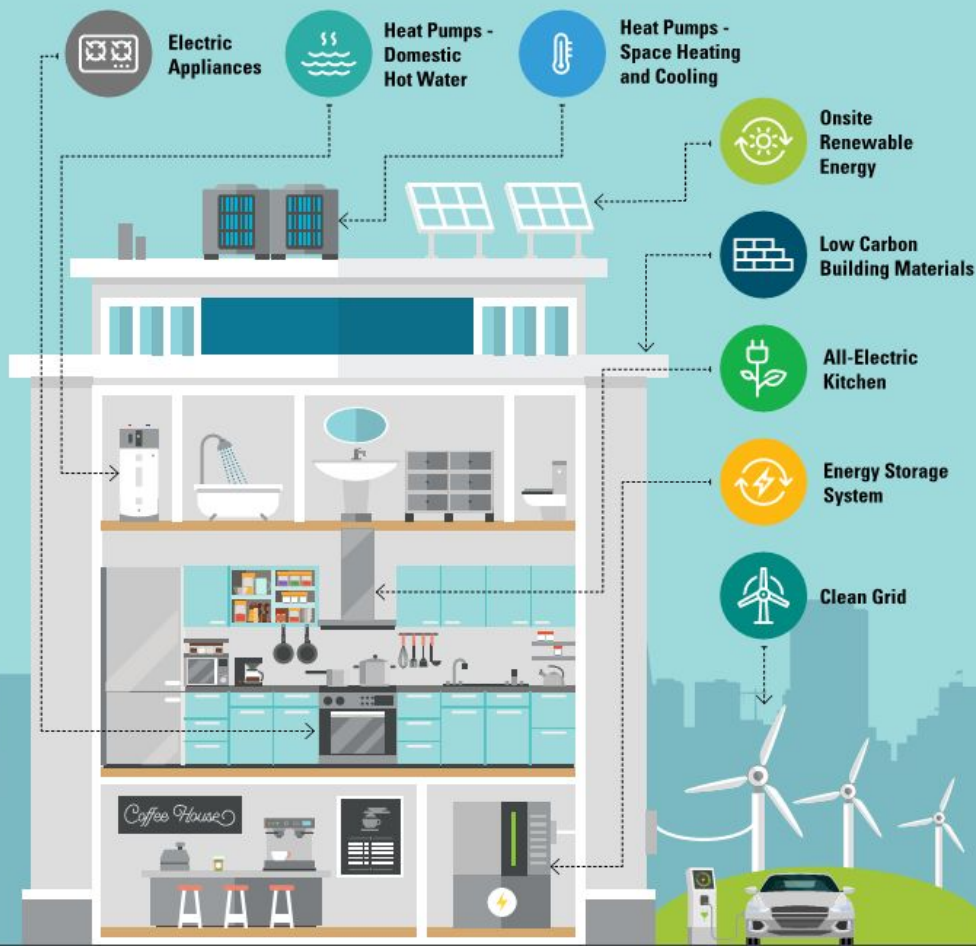
» Multifamily Residential, Hotels/
Motels, and Similar Buildings

ACKNOWLEDGEMENTS

The William J. Worthen Foundation would like to thank the entire Working Group of experts behind the development of the Building Decarbonization Practice Guide.

RELEASE DATE

October 28, 2021

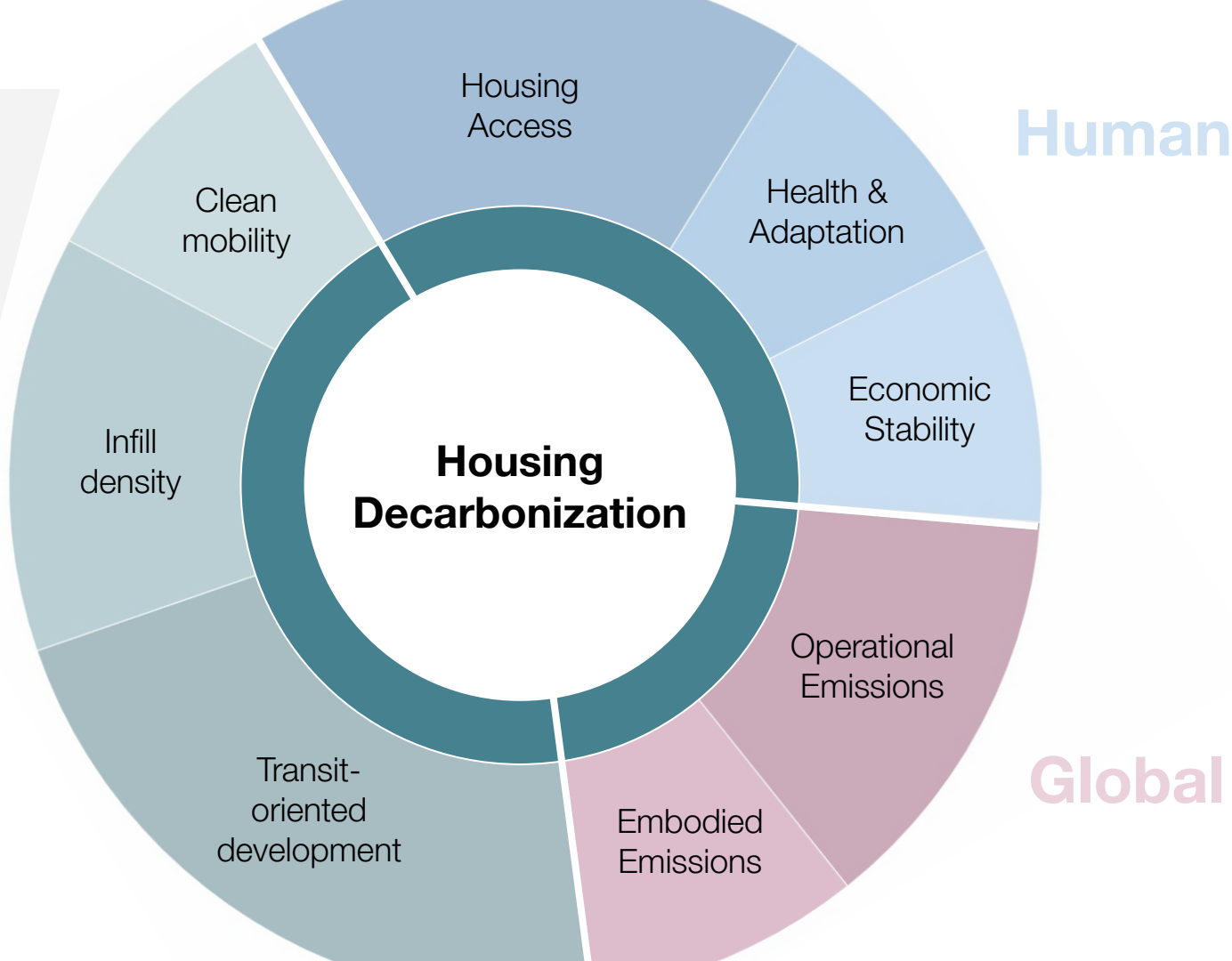


An aerial photograph of a coastal city. In the foreground, a modern, multi-story apartment building with a mix of white and dark brown facades stands on a street corner. To its left is an older, lower-density residential area with single-story houses. In the background, a large body of water (likely a bay or harbor) is visible, with a bridge and a city skyline in the distance. The text "What does it mean to decarbonize housing?" is overlaid in large, white, sans-serif font across the middle of the image.

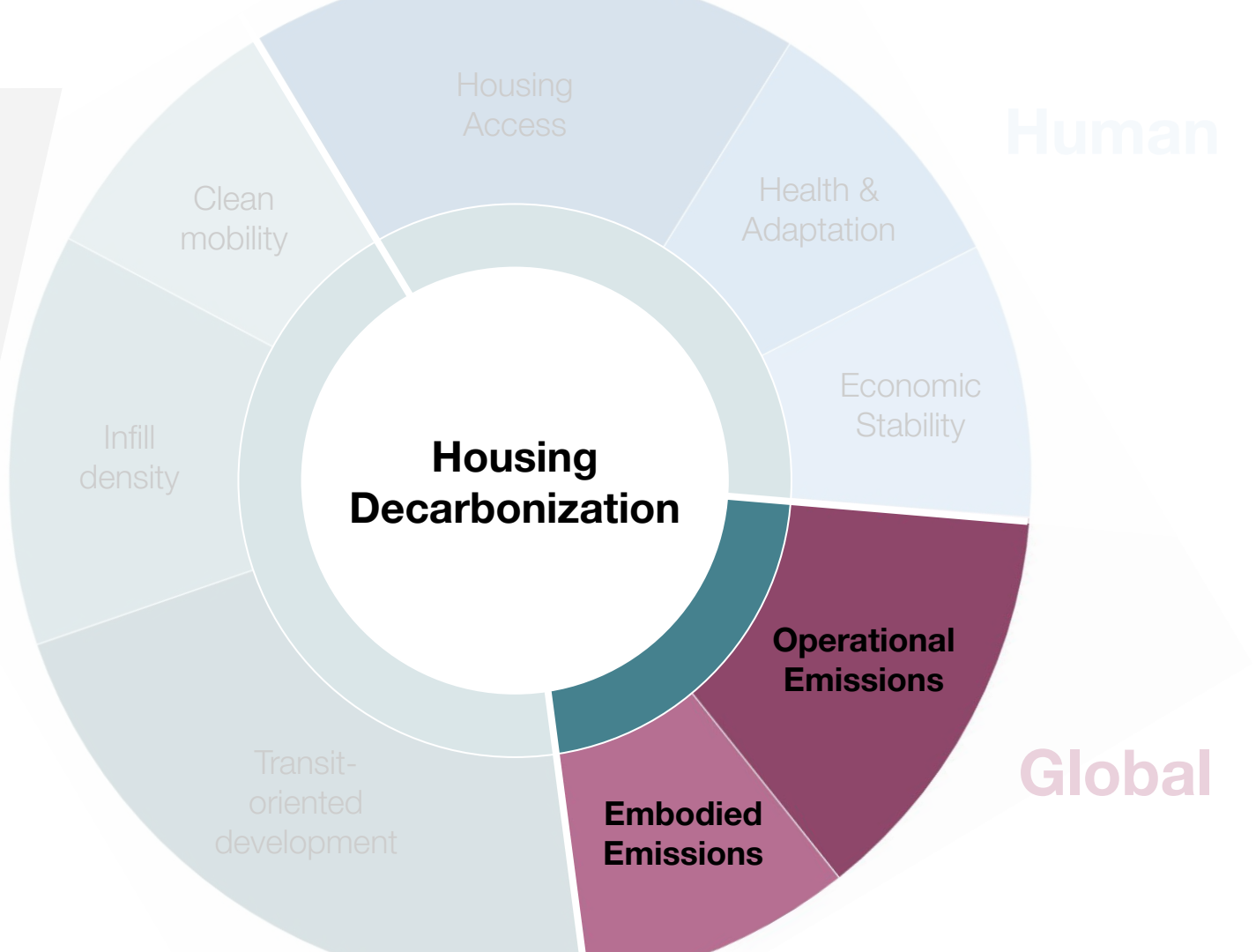
**What does it mean to
decarbonize housing?**

**Housing impacts
climate at
multiple scales.**

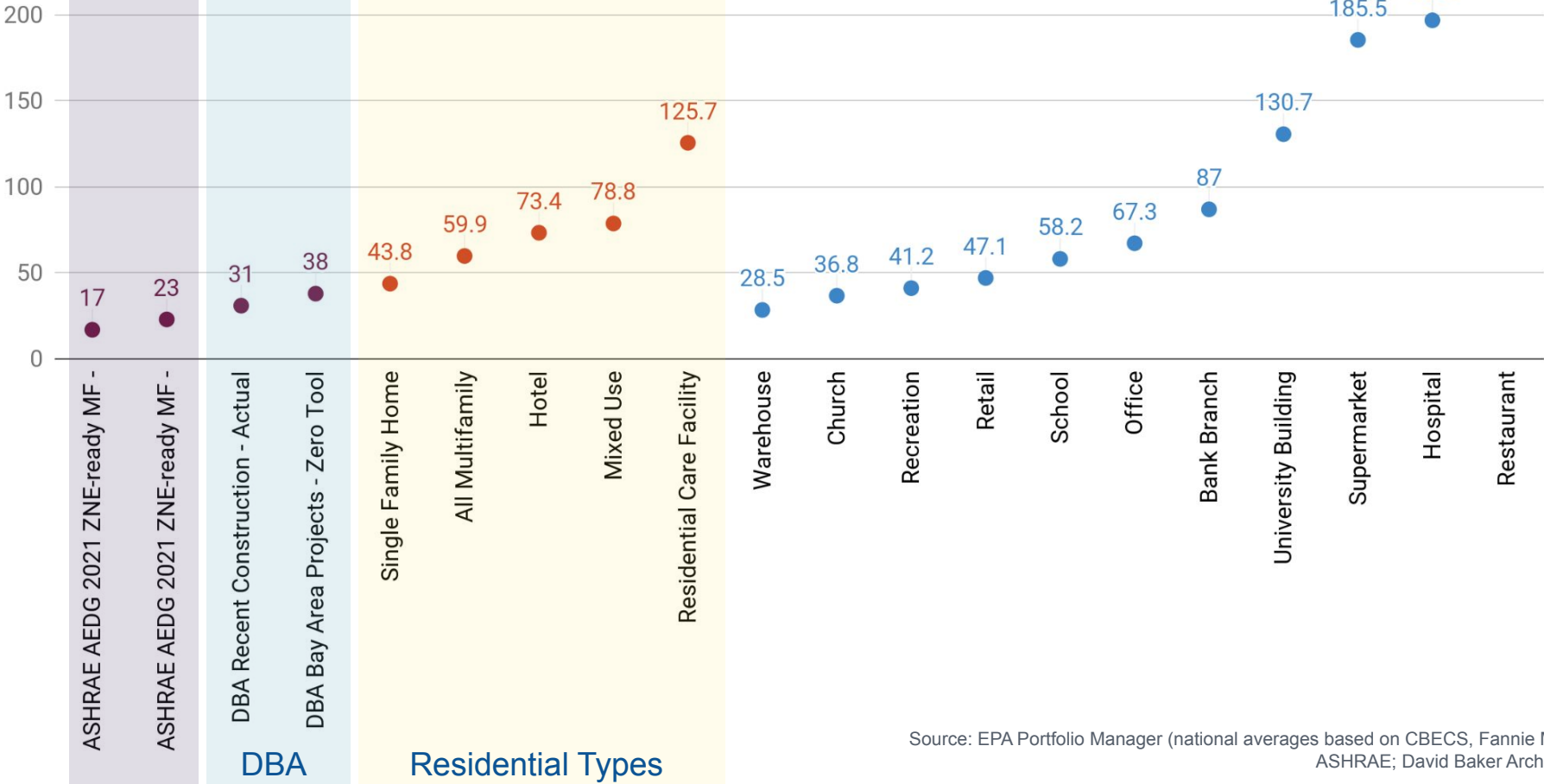
**Impacts are not
all easy to
measure.**



**Emissions
reduction of the
building itself is
usually the focus
of policy and
design standards.**



Multifamily Energy Use Intensity In Context



Source: EPA Portfolio Manager (national averages based on CBECS, Fannie Mae); ASHRAE; David Baker Architects

Multifamily Decarbonization Design Priorities

1. Build to the **maximum density** that economics allows to support permanent residence
2. Eliminate **permanent fossil fuel infrastructure** on-site
3. Establish and **design for the everyday needs of target residents** and operators

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4. Target **<25 kbtu/sf-year gross site energy use intensity**
5. Maximize **benefit of solar PV (and storage) to residents and housing providers**
6. Plan thoughtfully for **electric vehicles** another other low-carbon modes of transportation
7. Exercise **simple, efficient material use** and industrialized construction methods

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9. Work to **reduce grid emissions**











Today's Focus

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What is already electric?

	New Market Rate	New Affordable	Existing Affordable
Fire place	X	NA	NA
Range/Cooktop	X	✓	X
Space heating	✓	✓	?
Space cooling	✓	✓	✓
BBQ	X	?	X
In-unit dryers	✓	✓	?
Common dryers	NA	?	X
Water heating	X	X	X

What is already electric?

	New Market Rate	New Affordable	Existing Affordable
Fire place	 	NA	NA
Range/Cooktop	 	✓	
Space heating	✓	✓	
Space cooling	✓	✓	✓
BBQ	 		
In-unit dryers	✓	✓	
Common dryers	NA		
Water heating			

New Construction



Design Process | Key decisions

Massing,
Yield Study



Programming



Consultant
Procurement



Early Design
Analysis

- Understand local electrification incentives, REACH codes
- Set up for heat pump location and efficient hot water distribution
- Establish goals, owner requirements, resident service needs
- Early groundwork for resilience planning
- Ensure energy modeling capabilities, technical assistance and commissioning are built into consultant RFP
- Evaluating systems options - know your success criteria
- Whole-building non-compliance model: PV and operating budget
- Resilience Planning

BUILD Program Incentives & Technical Assistance



Technical Assistance

Technical Assistance is available for low income all-electric residential building planning, project fuel-switching, low-emissions building design and technologies, and incentive application completion. Inquiries for technical assistance are now being accepted.

[INQUIRE >](#)



SMITHGROUP



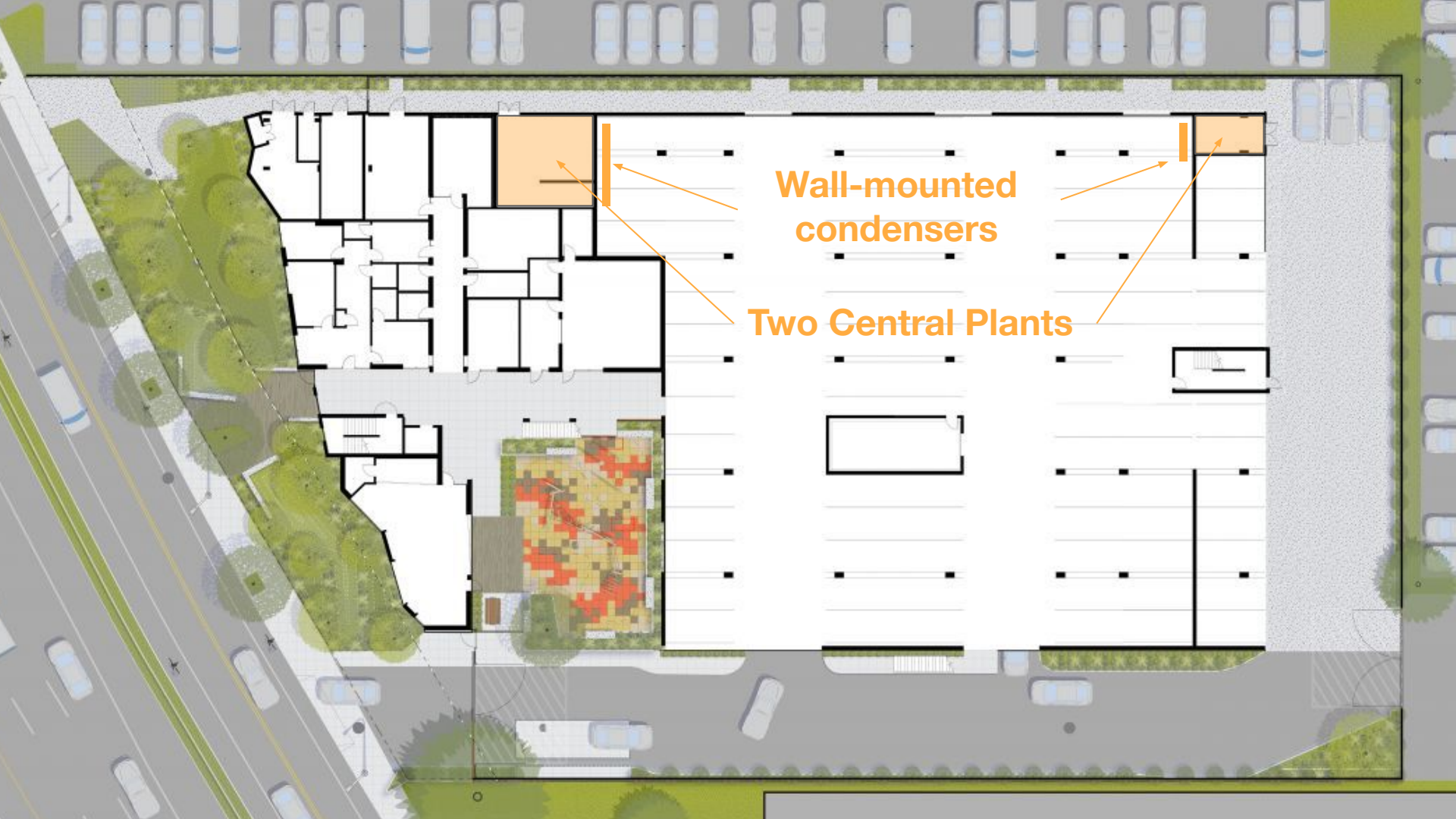
MITHŪN

Edwina Benner Plaza CEC Central HPWH Pilot Demonstration

The image shows a modern, multi-story building with a courtyard and playground. The building has a mix of dark blue, grey, and red siding. There are several balconies with glass railings. In the foreground, there is a playground with a large wooden structure and a slide. The ground is paved with a red and yellow checkered pattern. Several children are playing in the courtyard. The sky is clear and blue.

Completed
Space Heating/Cooling
Hot Water
Ventilation
Solar PV

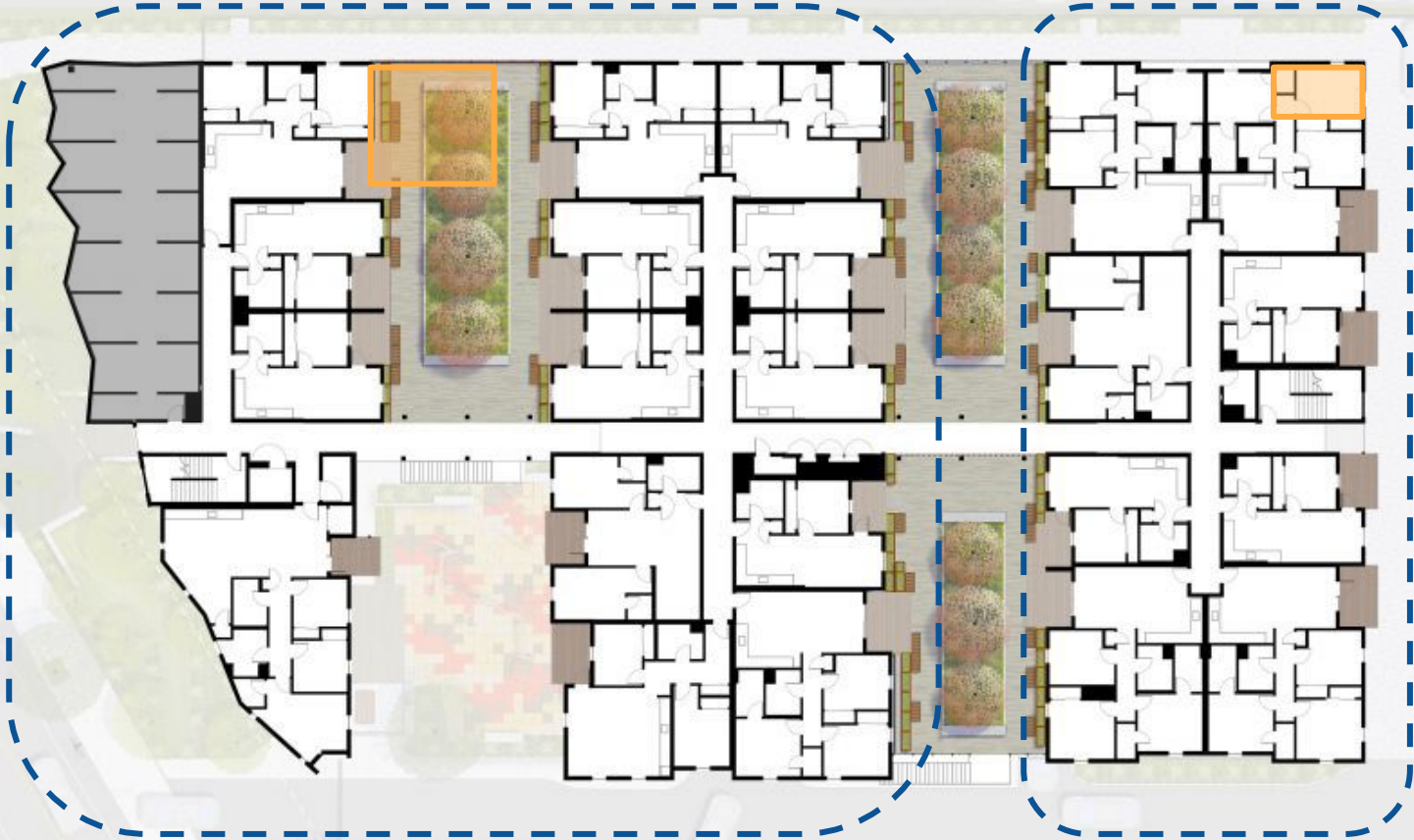
2018
Minisplits
Central CO2 heat pump
Central supply, side-wall exhaust
125 kW array



Wall-mounted
condensers

Two Central Plants

Compact Distribution





Construction Cost comparison



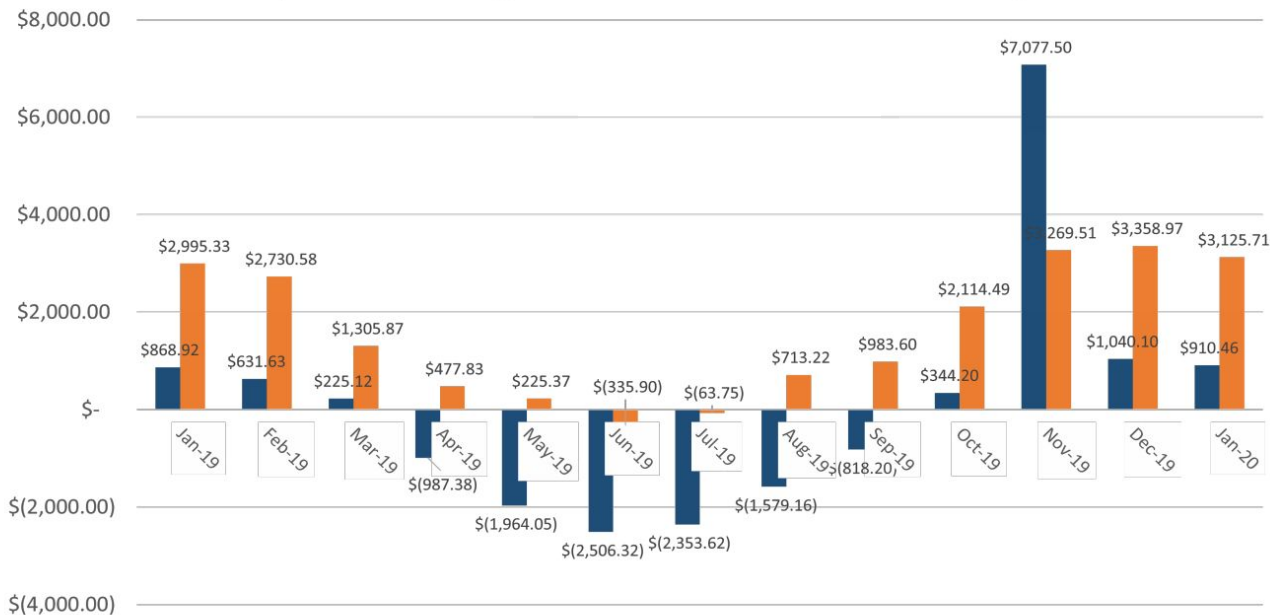
	Gas + Solar Preheating	Electric HPWH	Cost Difference per Unit
	Gas boilers Storage tanks Solar thermal preheating All gas infrastructures and connection	Heat pumps Storage tanks Some PV (to be Opex neutral) Transformer upscale/additional transformer	
Central system (2016)	\$3,000	\$3,200	+\$200
Central system (2021)	\$3,200	\$2,200	-\$1,000
Individual system (2021)	\$4,800	\$2,500	-\$1,300

Transformer placement can change economy/technical feasibility of the project

Operating Cost comparison



Monthly Energy Cost



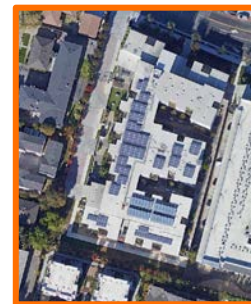
Courtesy: Amelie Besson, MidPen Housing



Edwina Benner

Completed 2018
All-electric
110,000 SF
66 family homes

Common area
energy costs 2019:
-\$21



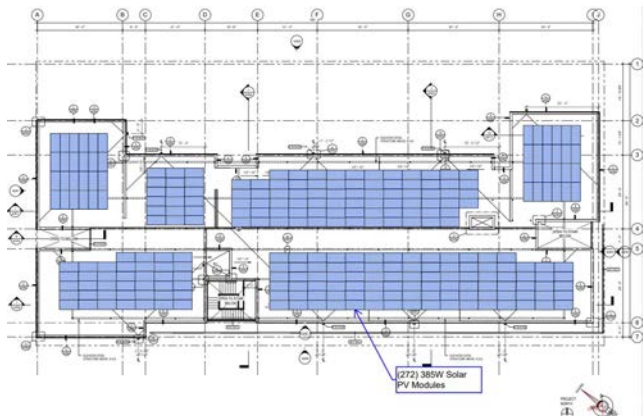
Onizuka Crossing

Completed 2015
Mixed Fuel
102,000 sf
58 family homes

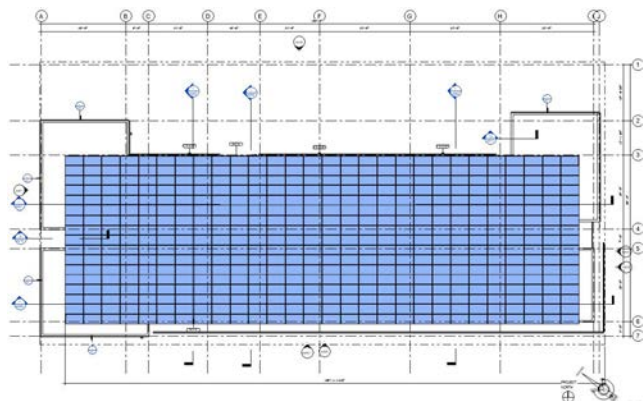
Common area
energy costs 2019:
\$17,775

**Same lot size, program, city,
developer, architect, MEP
engineer, and general contractor**

Housing as Energy Infrastructure?



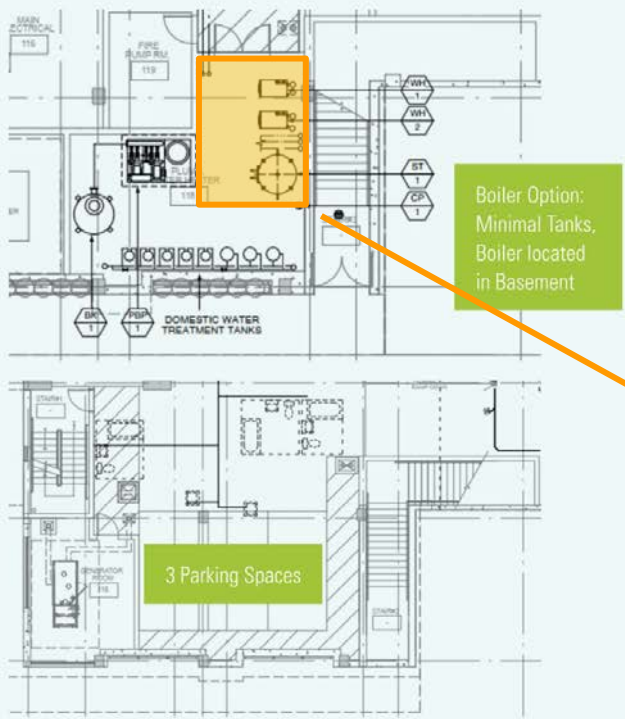
No canopy:
38% ZNE Offset
\$336,000 Cost
\$20,000 Annual Savings
Annual house utilities covered by PV



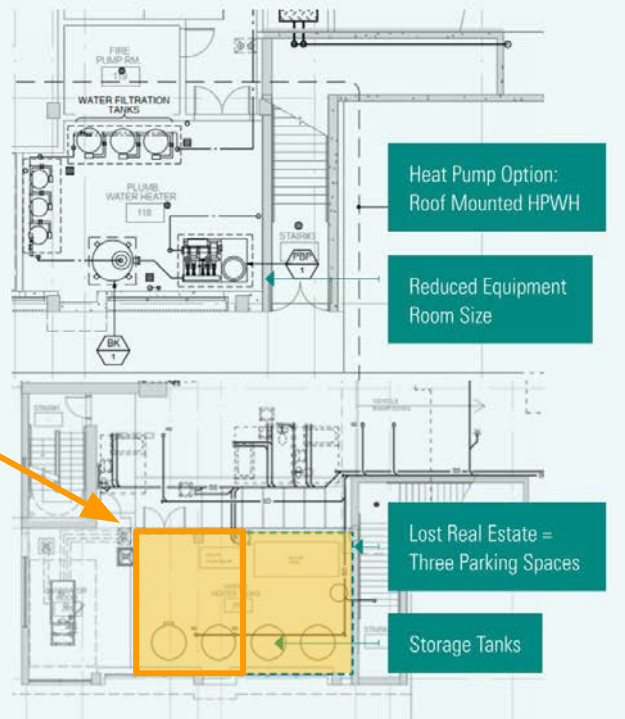
Elevated Canopy:
68% ZNE Offset
\$939,000 Cost
\$239,000 After Adjustments
This is after deducting \$300k from Federal Tax Credit and a credit of \$400k in increased loan based California Utility Allowance Calculator.
\$30,000 Annual Savings
Increased Annual Revenue from CUAC rent adjustments

Centralized heat pumps

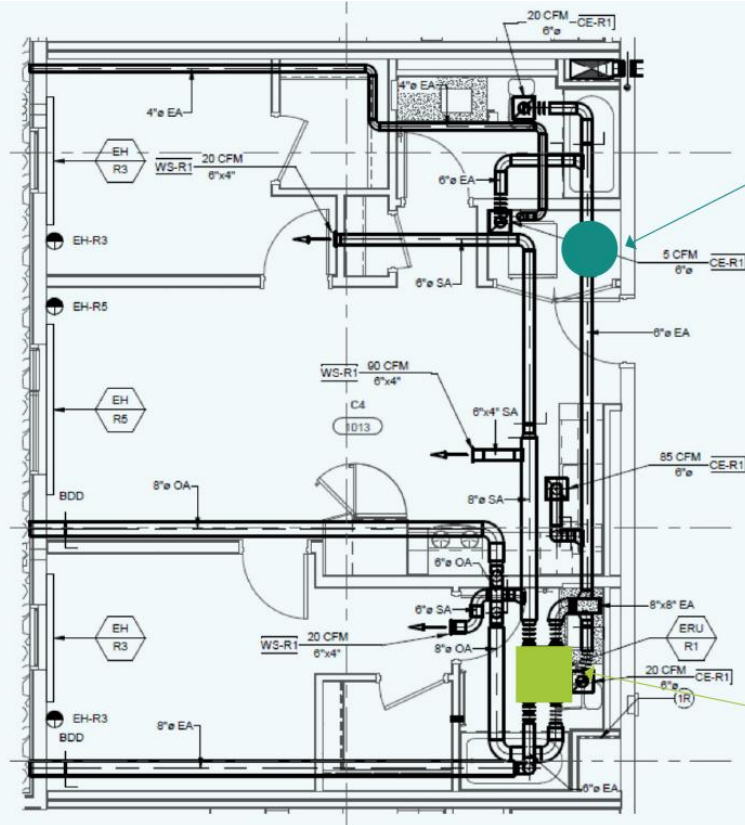
Gas Water Heating System



Electric Heat Pump Water Heating System



Decentralized, in-unit heat pumps

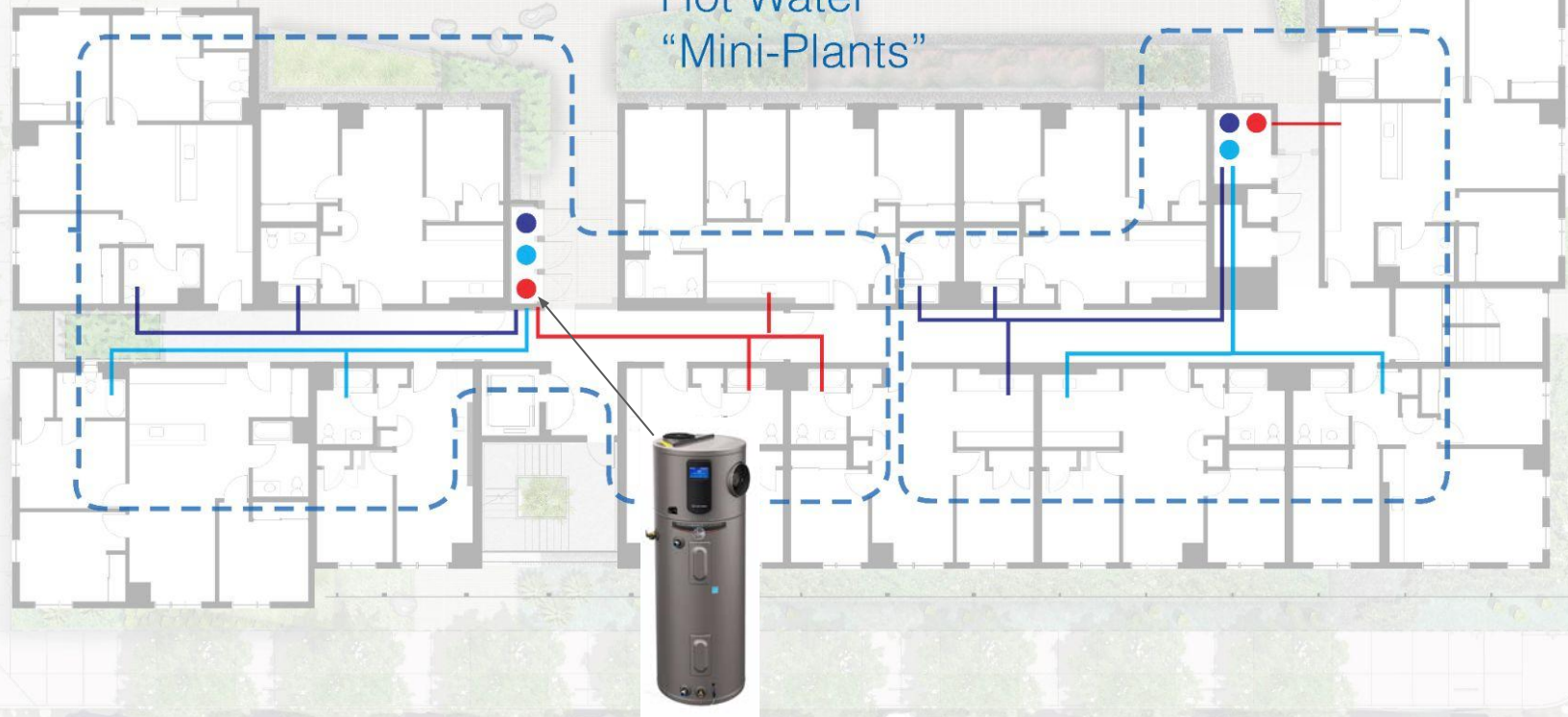


Heat Pump Water Heater
Co-located with Washer/Dryer

Energy Recovery Ventilator

Semi-centralized heat pumps

Non-Recirculating
Hot Water
“Mini-Plants”



Resilience planning | How do we define resilient design?

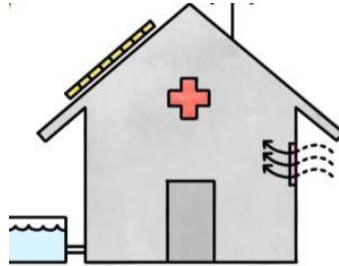
- Extending the useful life of the building (future-proofing)
- Keeping buildings running and staff supported during a critical event
- Keeping residents safe & well in livable homes

Resilience planning | what scale?

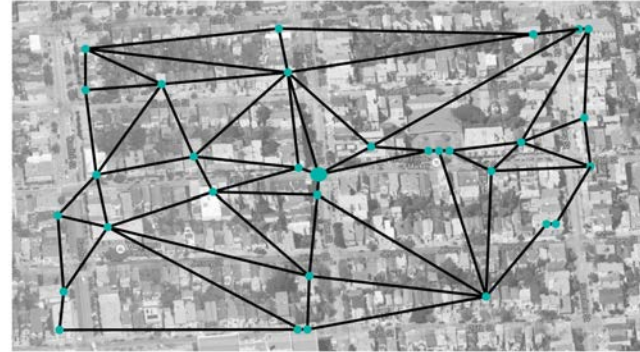
Residential Units



Residential Commons



Community



Resilience planning | Power failure in affordable & supportive housing

Critical & priority services

Staff offices
and server
room lighting
& power

Community
Room
power &
refrigeration:

Central ventilation
and hot water:
some residents
can't easily leave
their units

Common area
lighting continuity
is helpful for
residents with
PTSD

Building
Internet, CCTV
& Security
Cameras

Elevators
need to be
functional

Ideal services

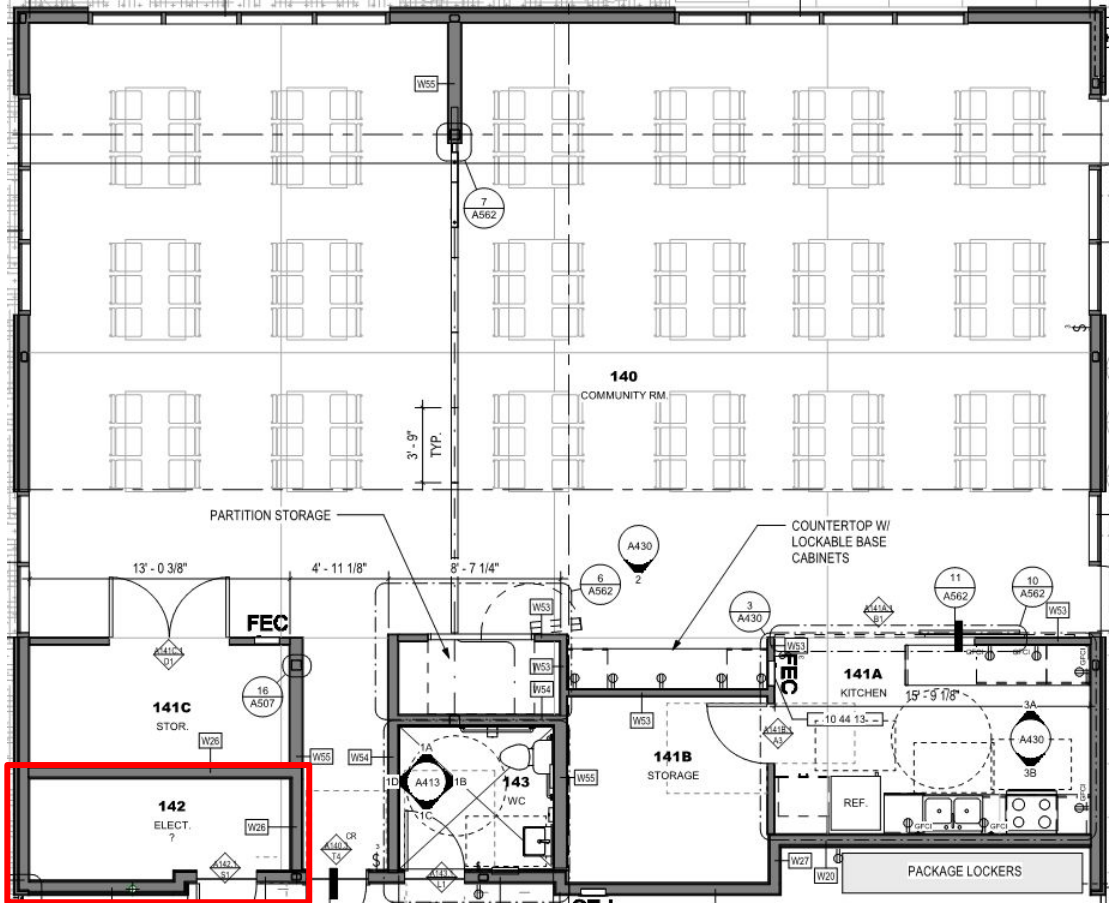
Staff offices
heating
and cooling

Community
Room
heating
and cooling

Computer lab
continuity for
communications
and youth
programs

Site &
Garage
gate power

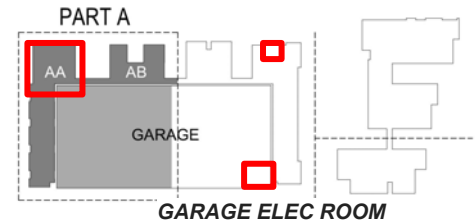
Resilience planning | Resilience Hub in Daly City



- Lights, outlets, refrigeration
- Battery Backup System:
 - 18kW dedicated PV
 - 15.2kW / 40kWh of capacity
 - (3) Tesla power walls
- 13-14 hours
- \$160,000 full cost
- \$6,500 “backup ready”

COMMUNITY ROOM
ELEC ROOM

RESIDENTIAL
ELEC ROOM



Resilience planning | Whole-building back-up system in New Orleans

- Master-metered 50-unit building
- Battery Backup System + ZNE design
 - high-efficiency HVAC
 - distributed heat pump hot water
 - 178kW solar array
 - 125kW / 371kWh capacity
 - (1) Dynapower battery system
- 8 hours
- \$350,000 for solar PV
- \$400,000 for batteries
- Applied solar tax credit + utility grant



Courtesy: Z Smith, Eskew Dumez Ripple Architects

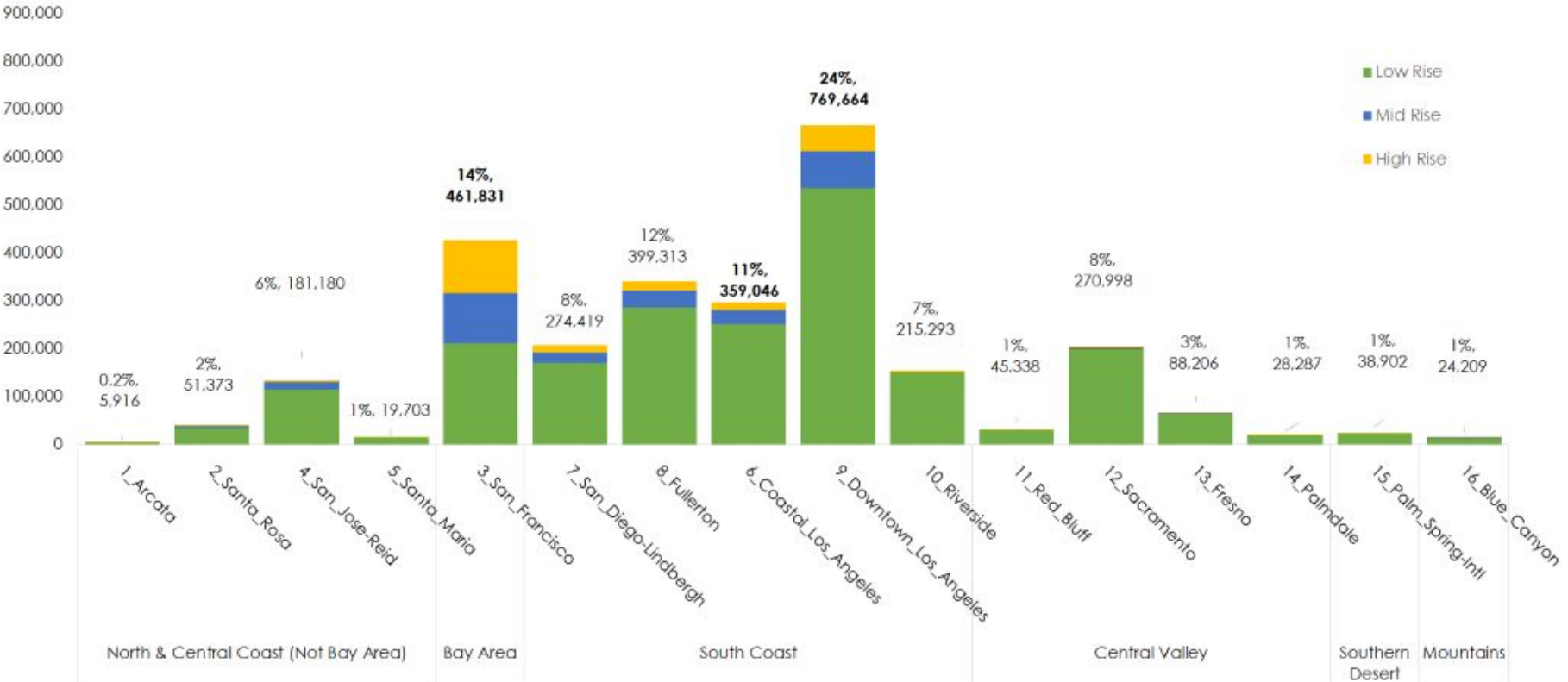
Resilience planning | Back-up power take-aways

- Backing up the whole building on a larger battery (Tesla Powerpack) may be simpler and more cost-effective. But still expensive.
- Having decentralized, individual systems helps control in-rush current
- Elevators & recirculation pump loads are too big; typically need generators
- Separate life-safety systems from other back-up services
- Wiring for battery-ready is an option
- Tanked fuel can't sit around, must be used. Feed back to the grid
- Dispatchable generation is a thing (utility manages generators / batteries)

Retrofits



California Existing Multifamily Building Stock

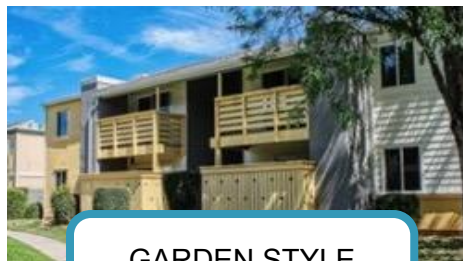


Building Typologies | For retrofit packages



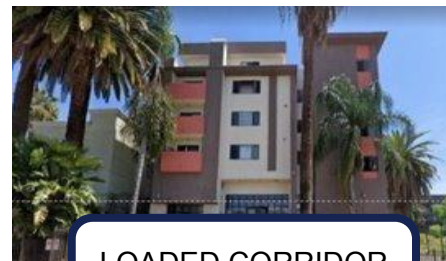
TOWNHOUSE
762,018 Units

- 5-9 Units, 2 Stories: 70%
- Pre-1980: 60%
 - 80s-90s: 30%
 - Modern: 10%



GARDEN STYLE
647,511 Units

- 10-19 Units, 2 Stories: 70%
- Pre-1980: 60%
 - 80s-90s: 30%
 - Modern: 10%



LOADED CORRIDOR
629,470 Units

- 20-49 Units, 2-3 Stories: 79%
- Pre-1980: 62%
 - 80s-90s: 27%
 - Modern: 11%

Heating	Natural gas gravity wall furnace Central gas forced air furnace	Natural gas gravity wall furnace Central gas forced air furnace	Natural gas gravity wall furnace Electric Resistance Heater Central Steam/Hydronic Boiler
Cooling	No cooling In-unit system	No cooling In-unit system	No cooling In-unit system
DHW	In-unit non-condensing tank	In-unit/central non-condensing tank Central boiler	Central Non-condensing tank Central boiler

Non-energy issues!

- No wall or roof insulation. Energy use and comfort are major issues
- Addressing deferred maintenance on general plumbing is a high priority
- Rooftop PV and electrification are also high owner priorities
- Major stucco damage and some interior pest and dry-rot damage
- Interior gyp and exterior stucco are both hot (asbestos)
- No exterior sheathing, inadequate and damaged lateral bracing



Retrofit Strategies | Menu of Options

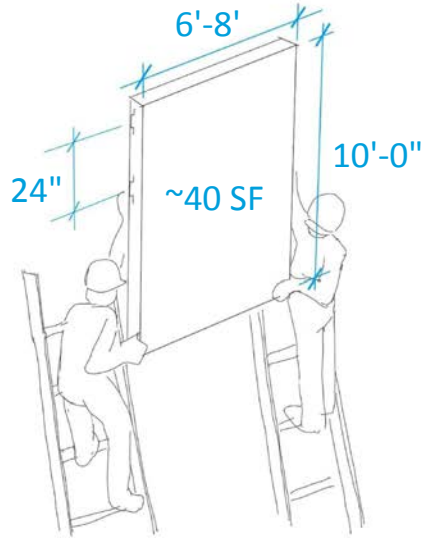
Conventional

- Re-cladding/new weather barrier
- Manual, “drill & fill” insulation
- “Piggy-back” dual vinyl windows
- High-performance storm windows
- Manual attic air sealing
- Roof-mounted PV
- Full HVAC replacement
- Heat pump water heater upgrade

Emerging and/or industrialized

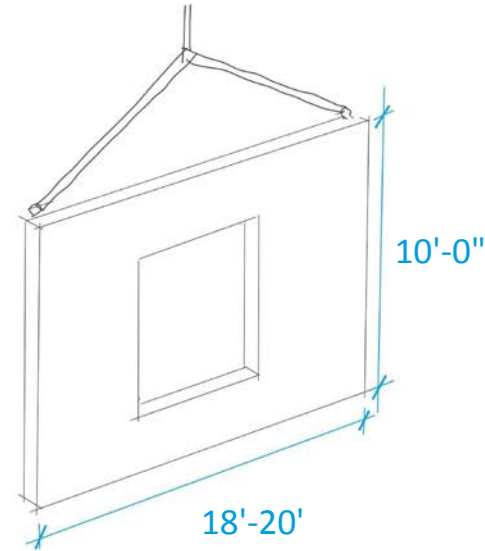
- Prefabricated, panelized insulated wall over-cladding
- Thin-triple nail-fin windows
- Aerobarrier
- Insulated metal panel roof with PV
- All-in-one HVAC + DHW
- All-in-one HVAC (new VHP)
- Phenolic ductwork
- Programmable sub-panels

Panel Technology Demonstration



Dryvit Fedderlite-M Panel

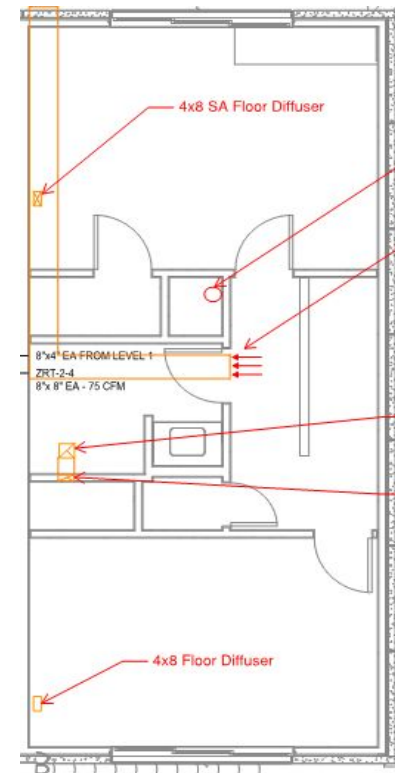
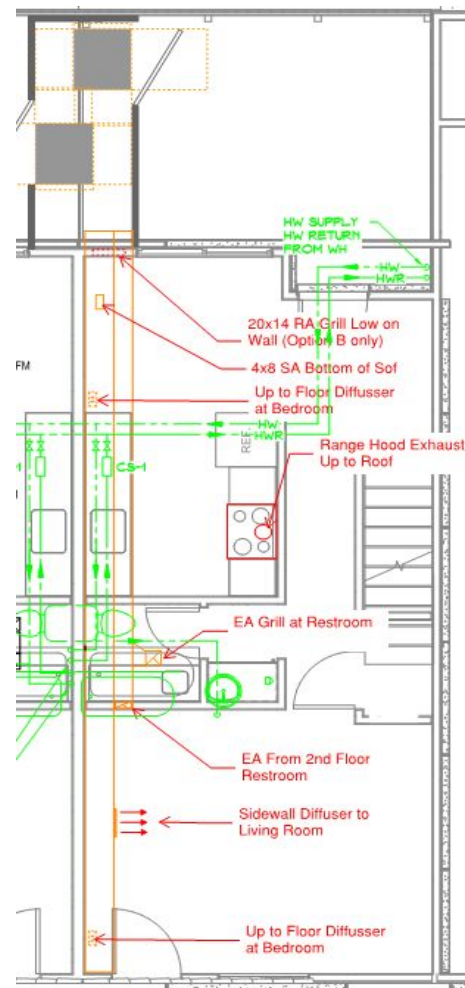
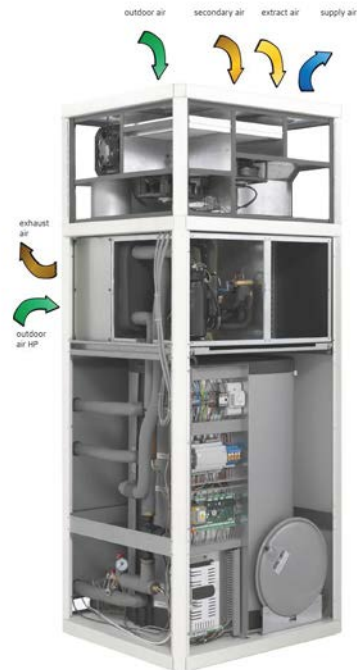
- Number of lifts 100 panels
- Weight 2.0-2.5 psf
- Thickness 2" - 6"
- Insulation R8-R29
- Cost \$42/SF
- Site-installed window




New structured Panel

- Number of lifts 40 panels
- Weight 5-7 psf
- Thickness 6" - 8"
- Insulation R20-R30
- Cost \$125/SF
- Factory-installed window

Mechanical “Pod” Demonstration



An aerial photograph of a coastal urban area. In the foreground, modern multi-story apartment buildings with white and dark brown facades are visible, situated along a street. To the left, there are older, lower-rise residential buildings. In the middle ground, a large body of water (likely a bay or harbor) stretches across the frame. A large ship is docked at a pier in the water. In the background, a city skyline with numerous skyscrapers is visible across the water. The sky is clear and blue.

It is imperative that decarbonization in this sector places community design, health and resilience at the center of decision making, rather than leading the conversation with greenhouse gas reduction targets.



Thank You