# Affordable Mixed-Use Development in a Carbon-Constrained Future


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# CEC EPIC Design Challenge for affordable mixed-use development

**Grid-Interactive**

**Climate Resilience**

**Critical Recovery**

**Affordability**

**Replicability**

# Energy and emissions evaluation overview

## Objective

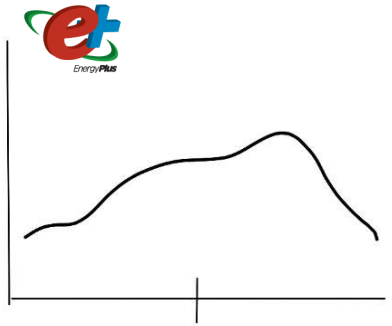
- Identify and evaluate design strategies and building systems that meet CEC's goals

## Approach

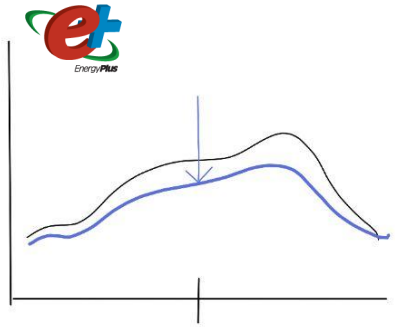
- EnergyPlus simulations
  - Calculate hourly end-use electricity and thermal loads
- Xendee optimizations
  - Shifts building loads to optimize for PV and energy storage cost and carbon impacts

## Funding

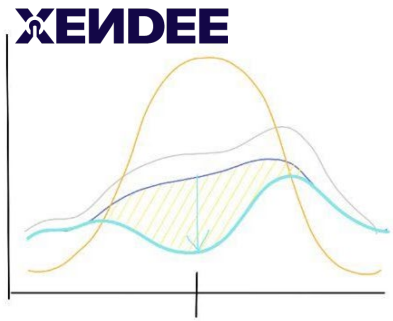
- CEC EPIC program



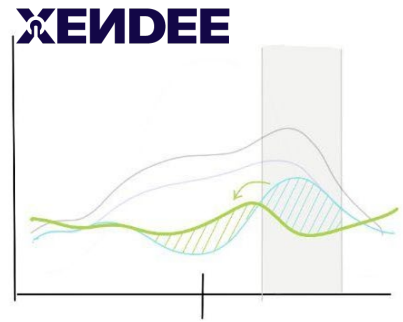
**1. Baseline power demand**



**2. Load reduction**
Efficiency
Energy recovery



**3. Renewables**
Rooftop PV

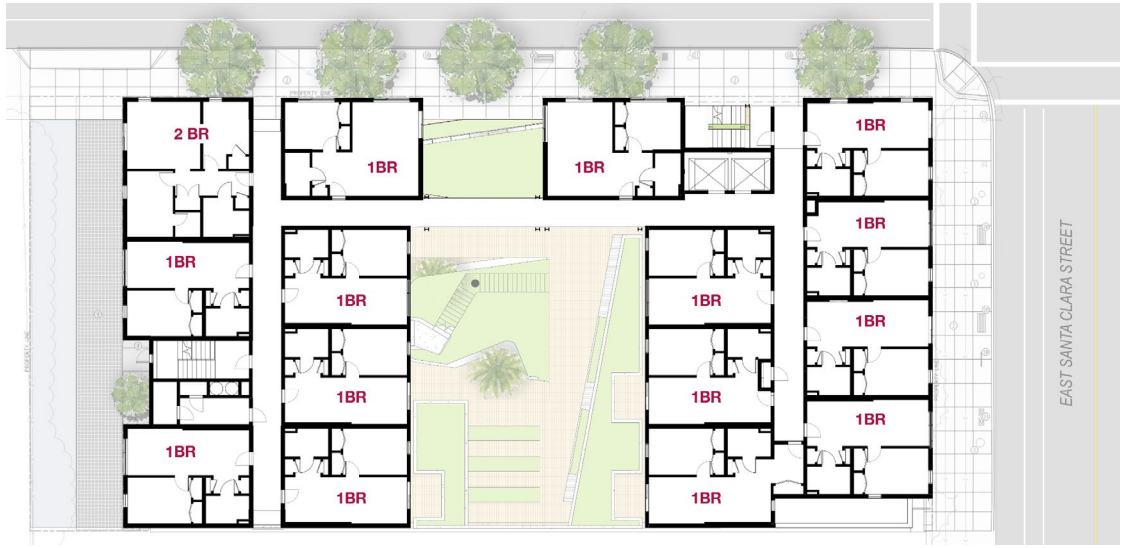


**4. Load shifting**
Load control
Thermal storage
Battery storage

# Roosevelt Village: 995 East Santa Clara Street in San Jose, CA

## Mixed-use, 6-story

- 74 apartments serving previously unhoused and very low-income seniors
- Supportive services, community rooms, food pantry, property management
- Courtyard with resident gardens

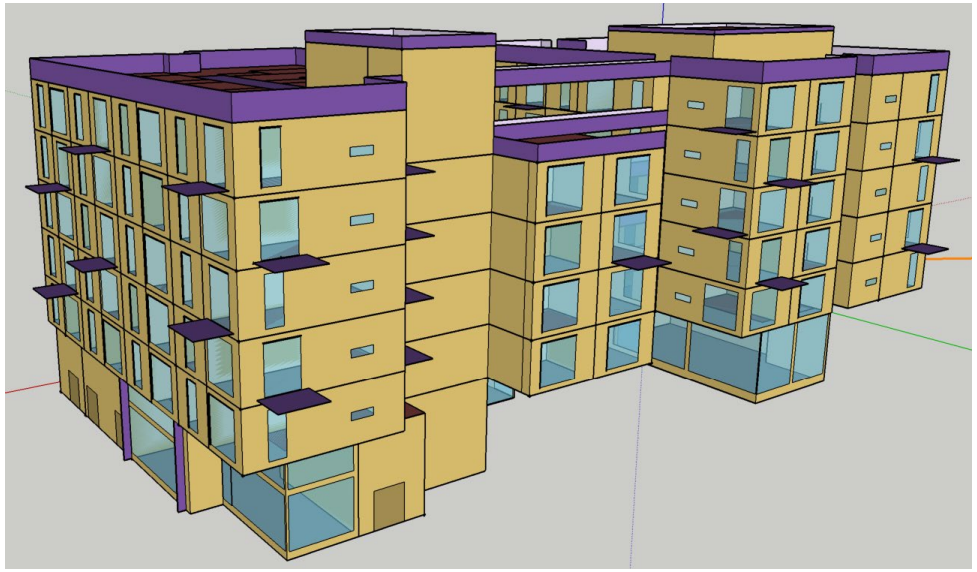



Rendering of the new construction proposal

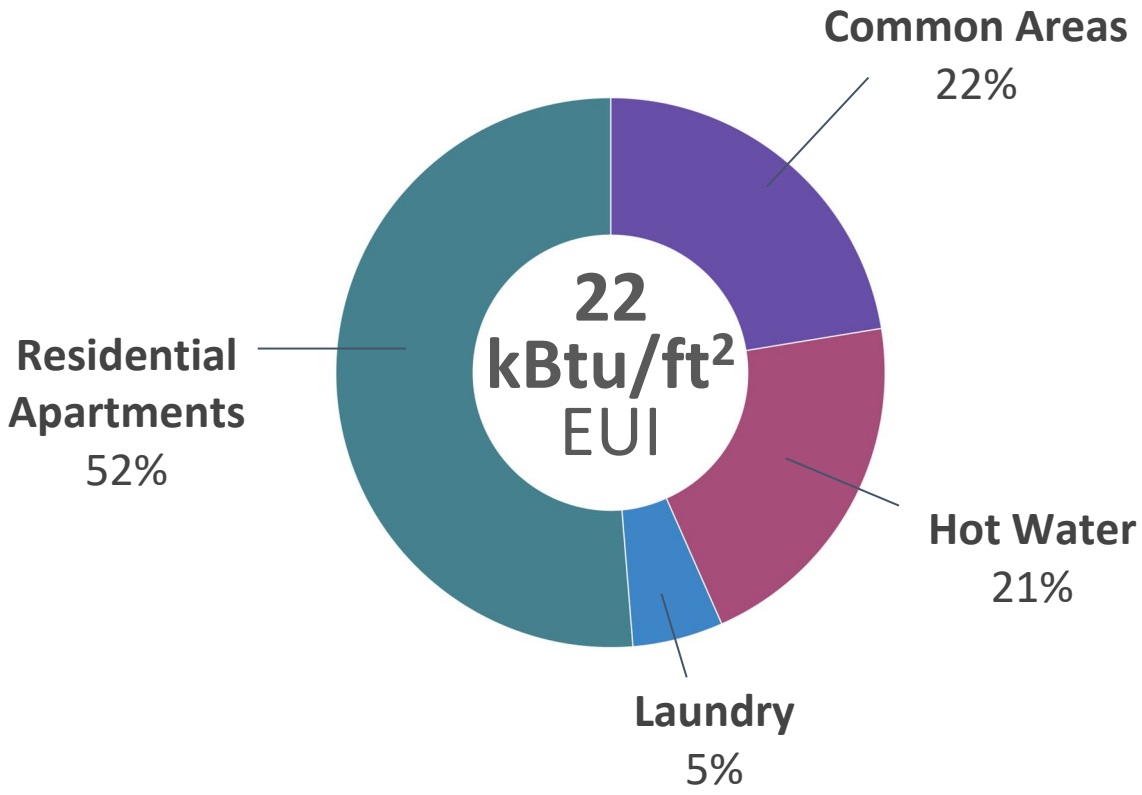
# Roosevelt Village: 995 East Santa Clara Street in San Jose, CA

## LEED Platinum baseline model

- All-electric building
- Central heat pump water heater
- Conventional packaged AC with heat pump
  - ‘PTAC’
- Central air supply, side-wall exhaust
- R-21 wall cavity insulation
- R-30 roof with tapered rigid insulation
- Double-pane vinyl windows
  - U 0.30 | SHGC 0.23
- LED lighting and EnergyStar appliances

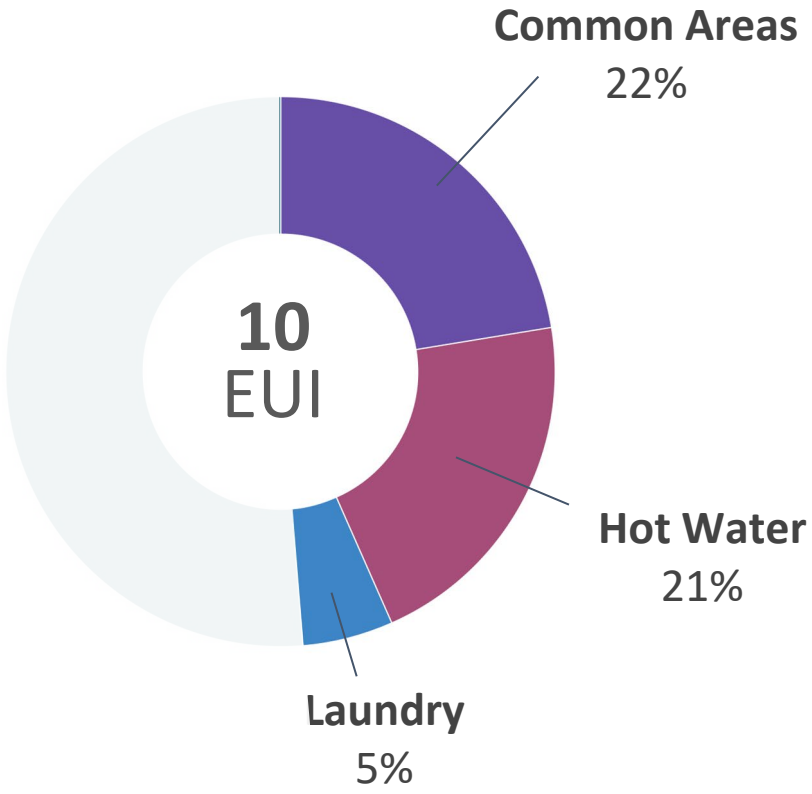


# Baseline Model: Annual energy use breakdown



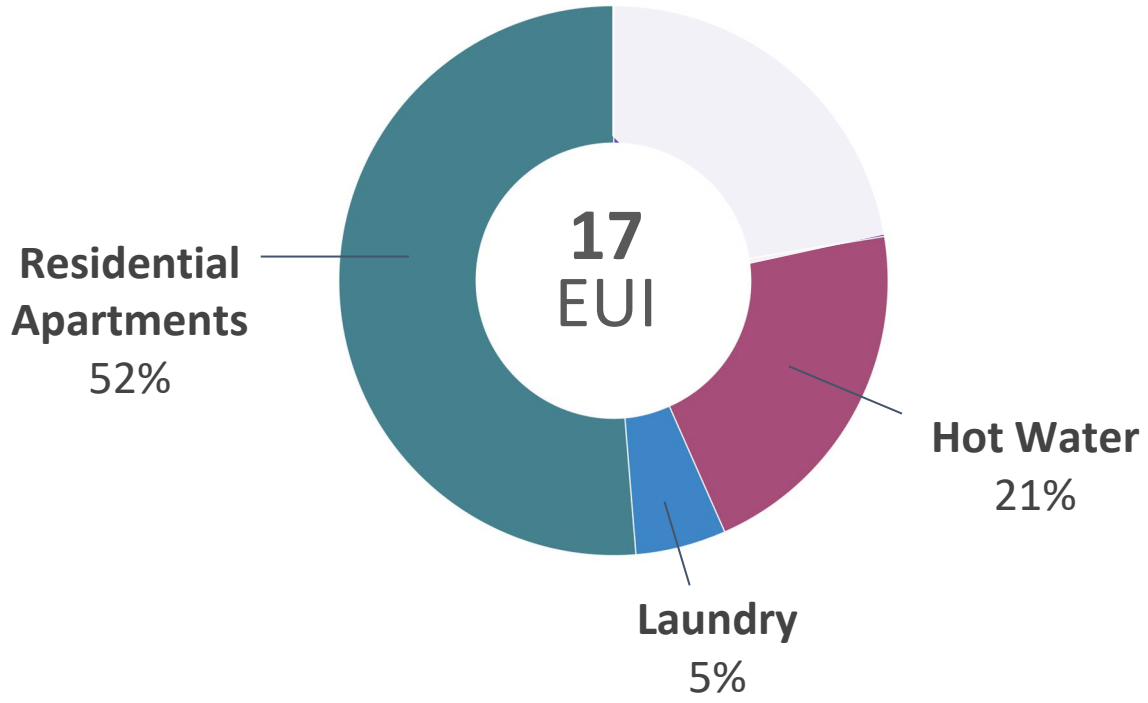
# Baseline Model: Annual energy use breakdown

**Common Meter**
48%

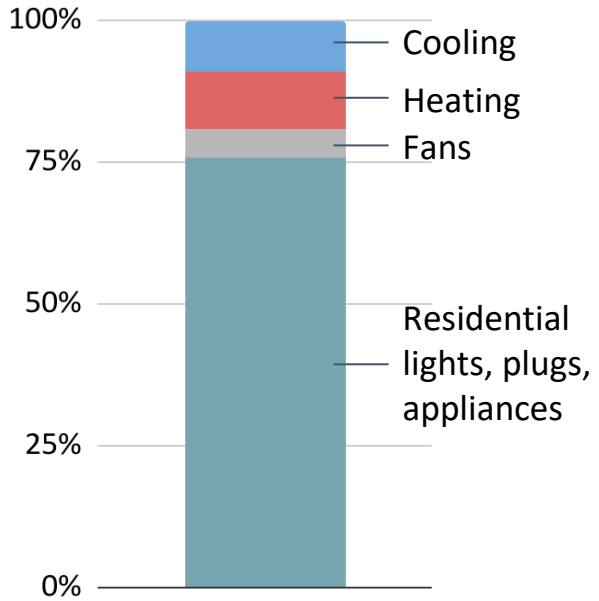


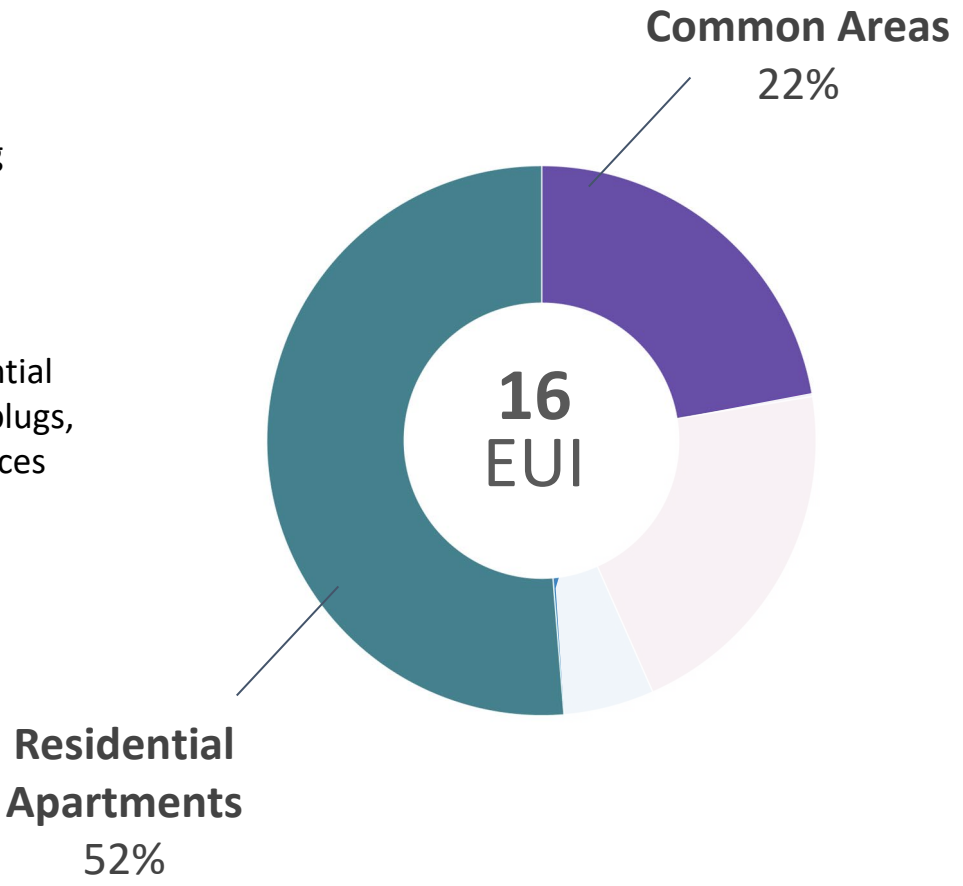
# Baseline Model: Annual energy use breakdown

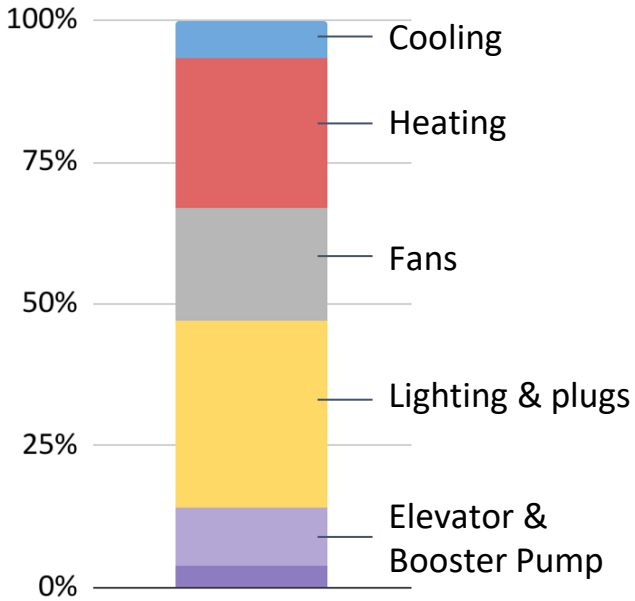
**Resident Behavior**
78%



# Baseline Model: Annual energy use breakdown

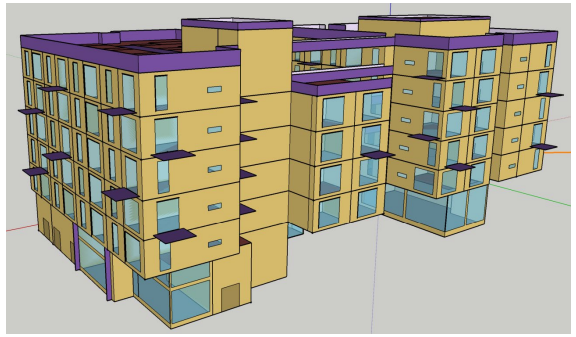


# Energy efficiency measures

## Baseline



**LEED Platinum project**

R-21 Wall cavity insulation
Air leakage: 2 ACH @ 50 Pa
ENERGY STAR Appliances
Low flow fixtures
Double-pane vinyl windows
(0.28 U, 0.23 SHGC)

## Cost-effective

350 kWh max fridge & induction
(5% overall equipment reduction)

Lower flow toilet and shower head
(15% DHW reduction)

Exterior shading
(18” protrusion)

Ceiling fans (relaxed cooling
setpoint from 75 °F to 78 °F)

Dynamic ventilation
(vary ventilation rate to shift load)

## All Measures

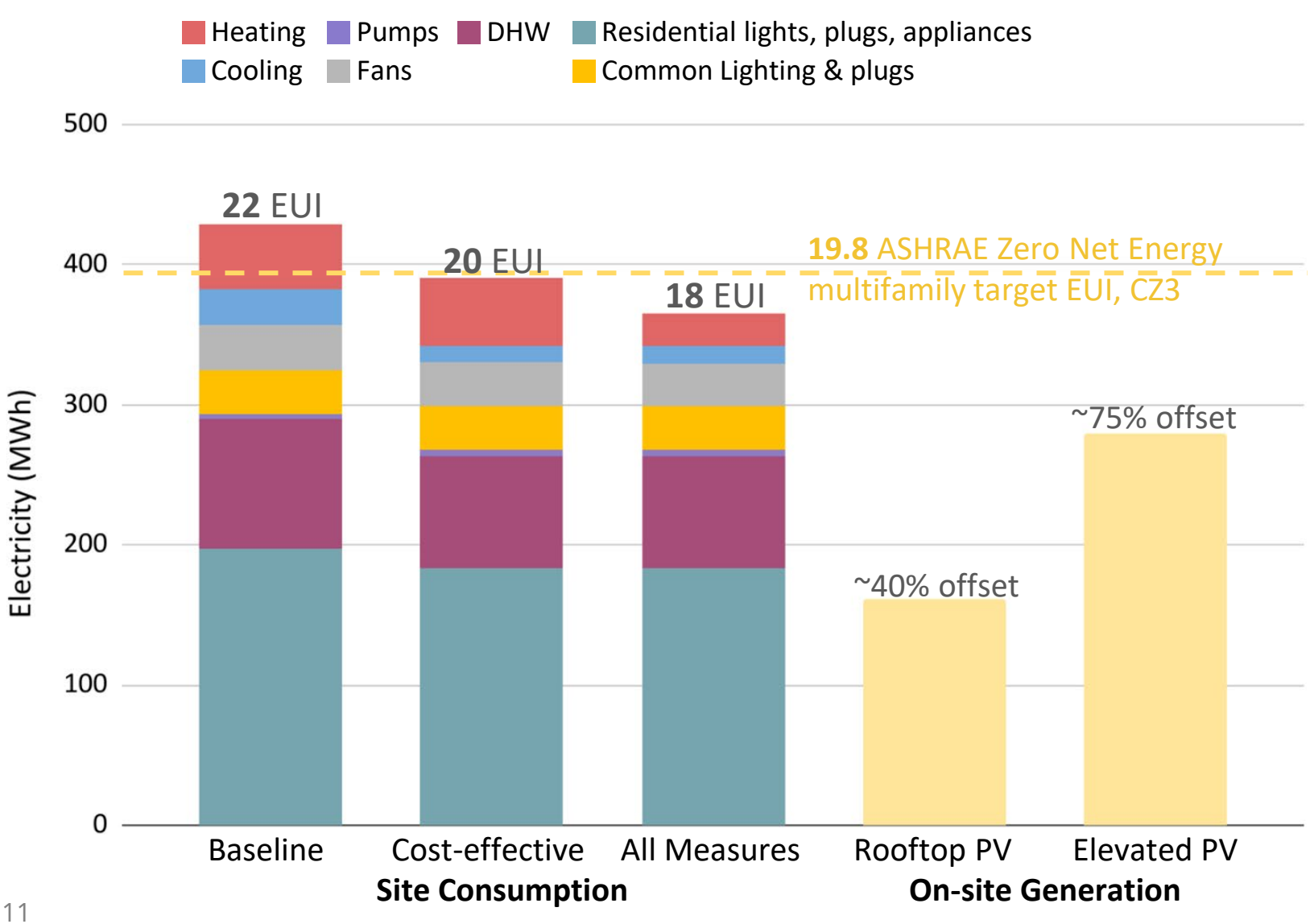
2” Continuous insulation

Air leakage 1 ACH @ 50 Pa

Reduced window to wall ratio
(height from 8 ft to 6 ft)

Thin triple vinyl windows
(0.16 U, 0.17 SHGC)

# Energy efficiency measures' impact on the baseline model




Rooftop mounted PV

Elevated PV

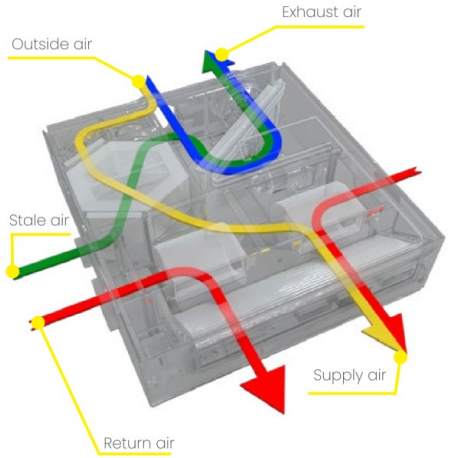
# HVAC alternatives with and without energy recovery ventilator (ERV)

## Baseline

### Conventional HVAC unit (Amana)

- Central ventilation with rooftop heat pump DOAS
- Central DHW via dedicated heat pump with no peak shifting control

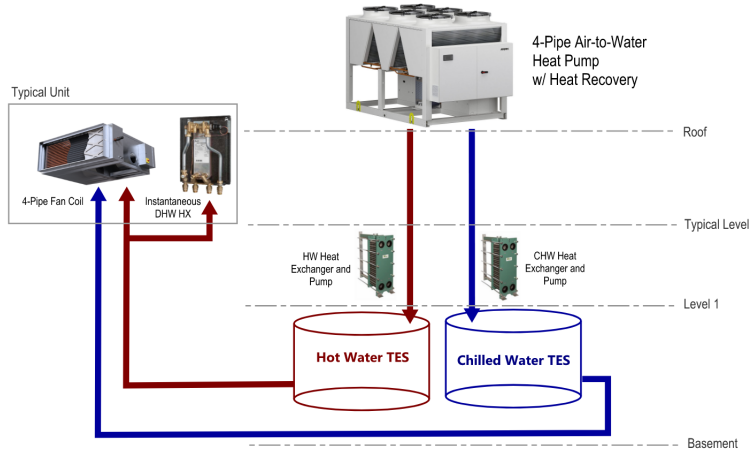
## Alternative 1




### Advanced HVAC unit (Ephoca)

- In unit ventilation or central ventilation
- Ducted or unducted wall-mounted
- Central DHW via dedicated heat pump with storage for peak shifting

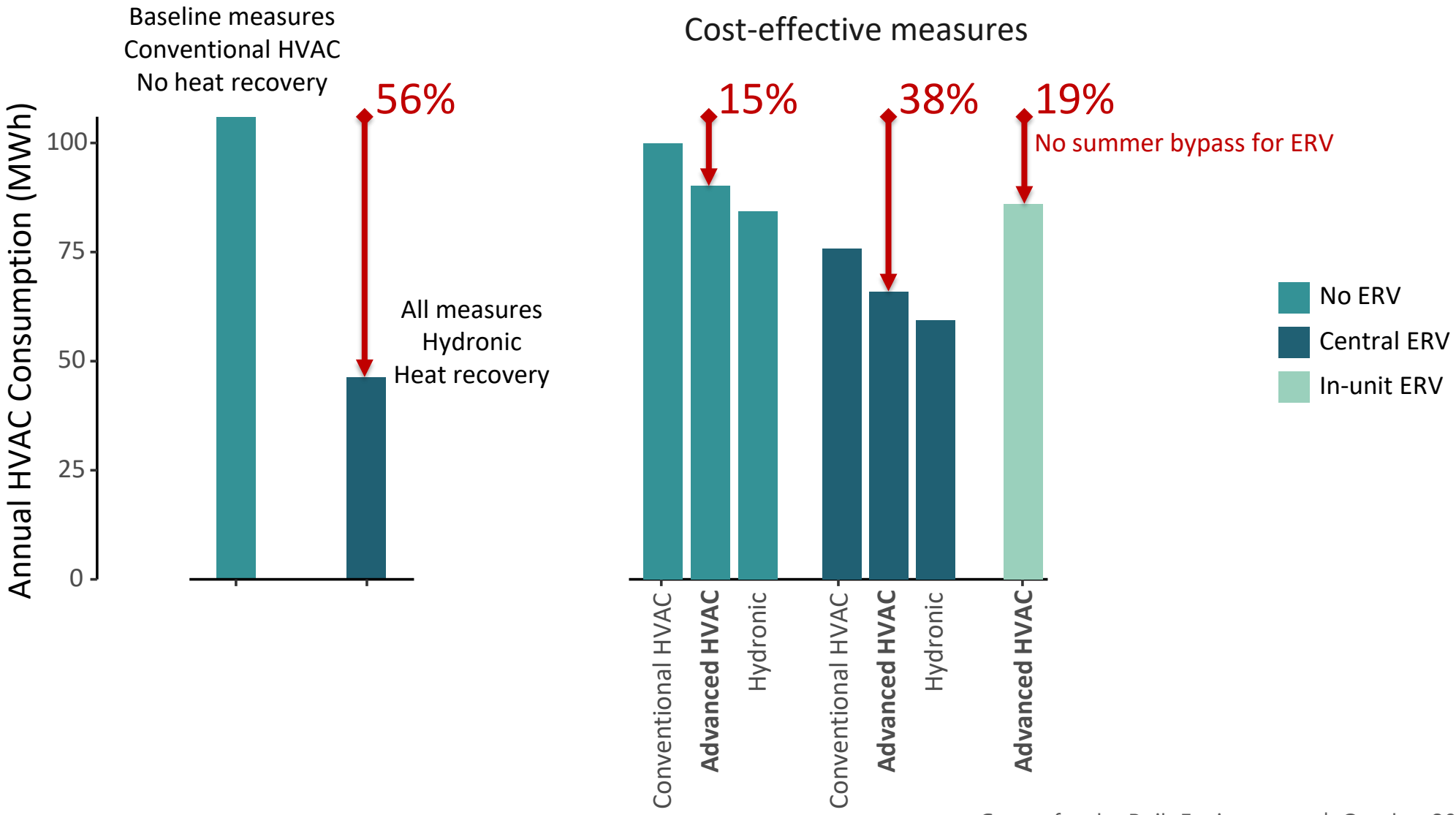
## Alternative 2



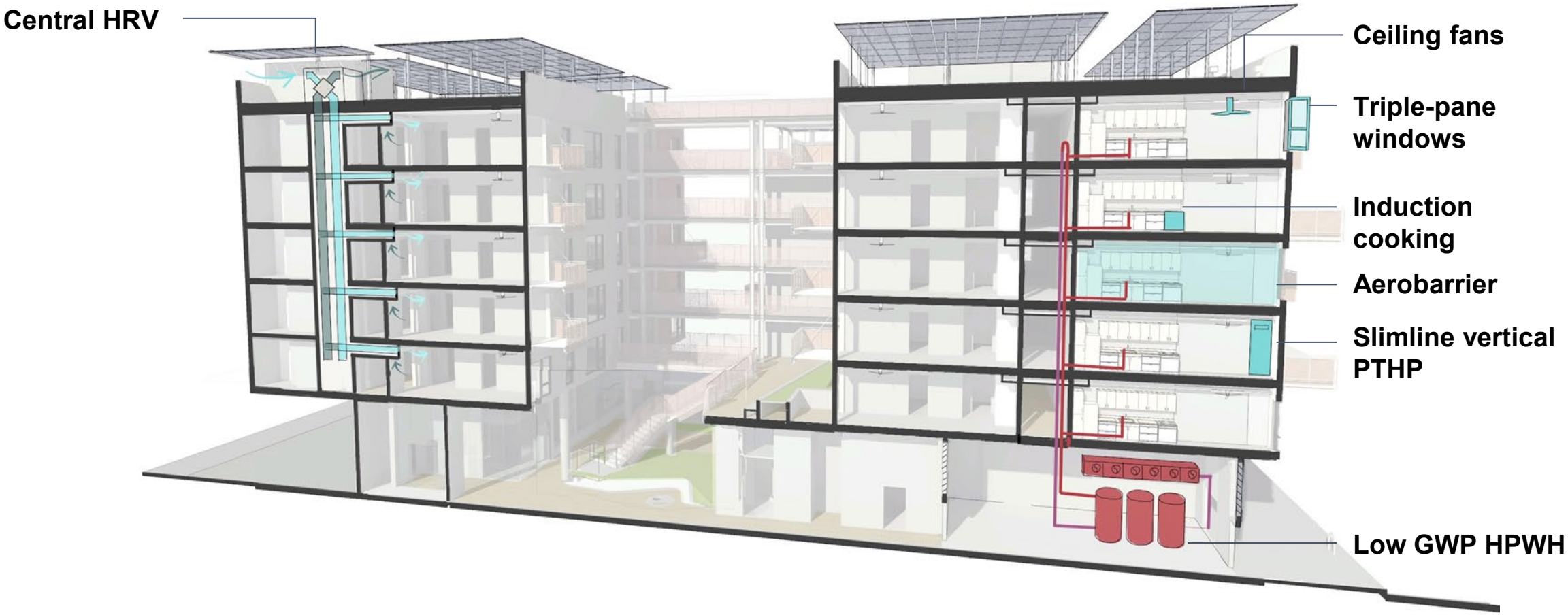

### Four-pipe hydronic system

- Central ventilation with 4-pipe DOAS air handlers
- 4-pipe fan coils
- Heat recovery and thermal storage
- In unit DHW via hot water heat exchanger

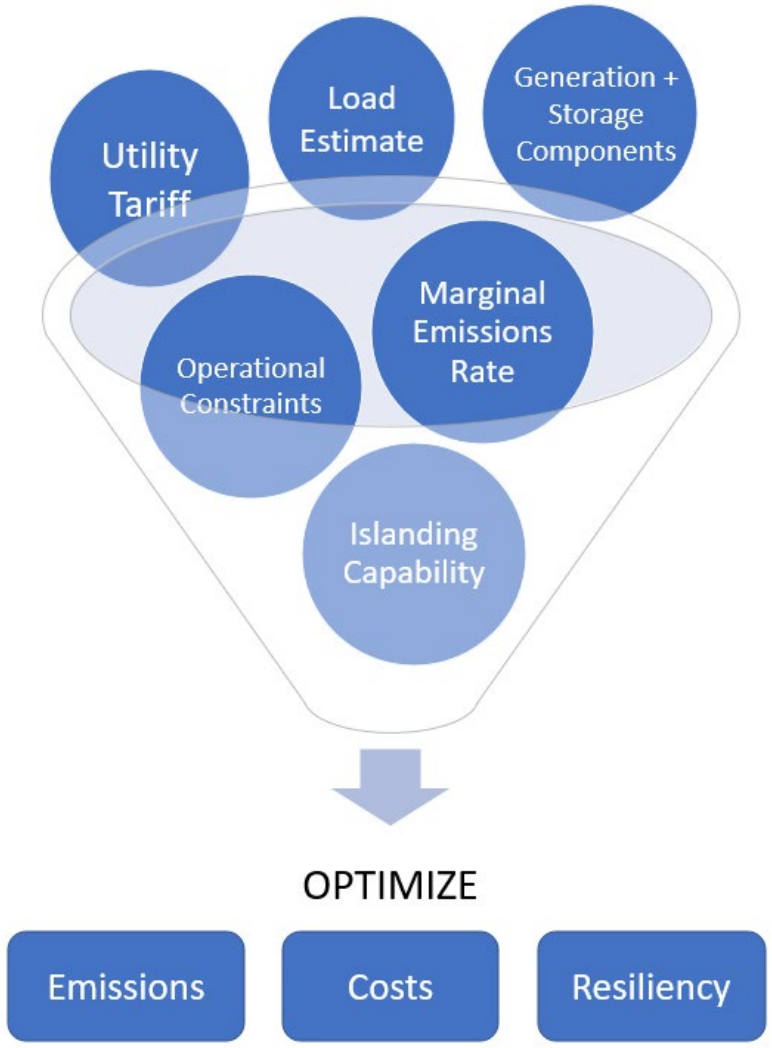
# Annual HVAC energy consumption



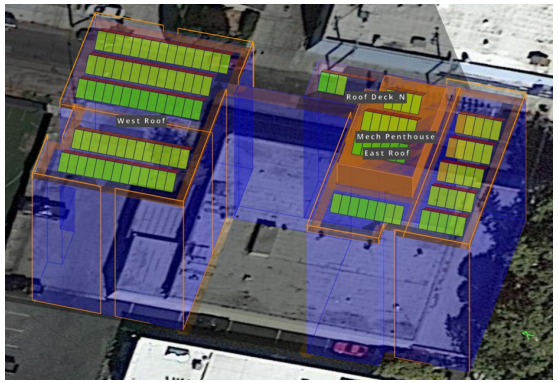
# Proposed energy efficiency package lowers 4-9pm load by 10%



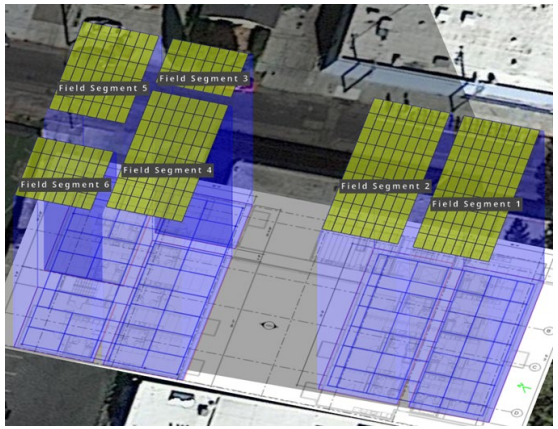
# Xendee: Cost & carbon optimization



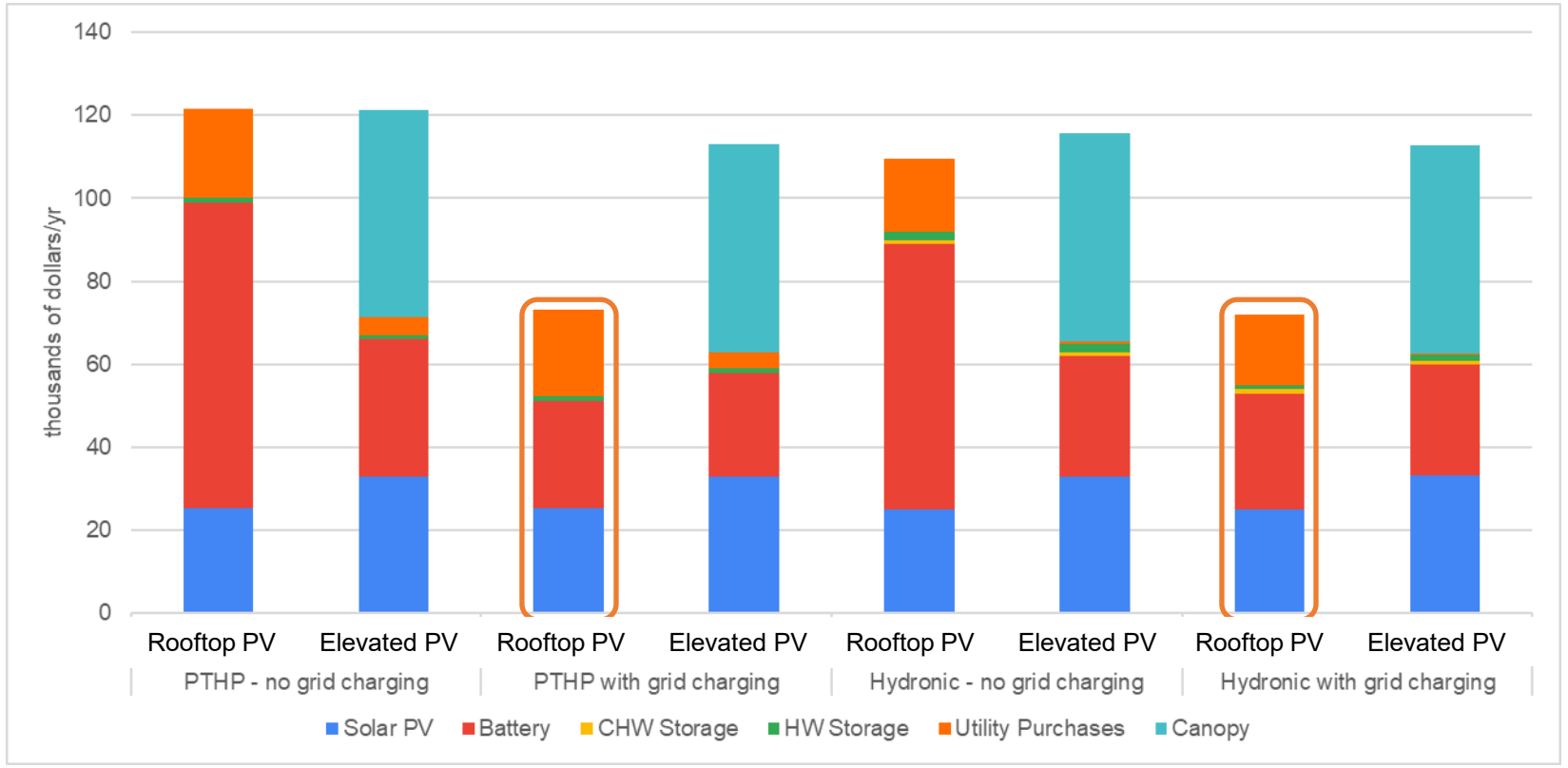
# Cost comparison of meeting all daily 4-9pm residential loads




Rooftop PV 130 kW

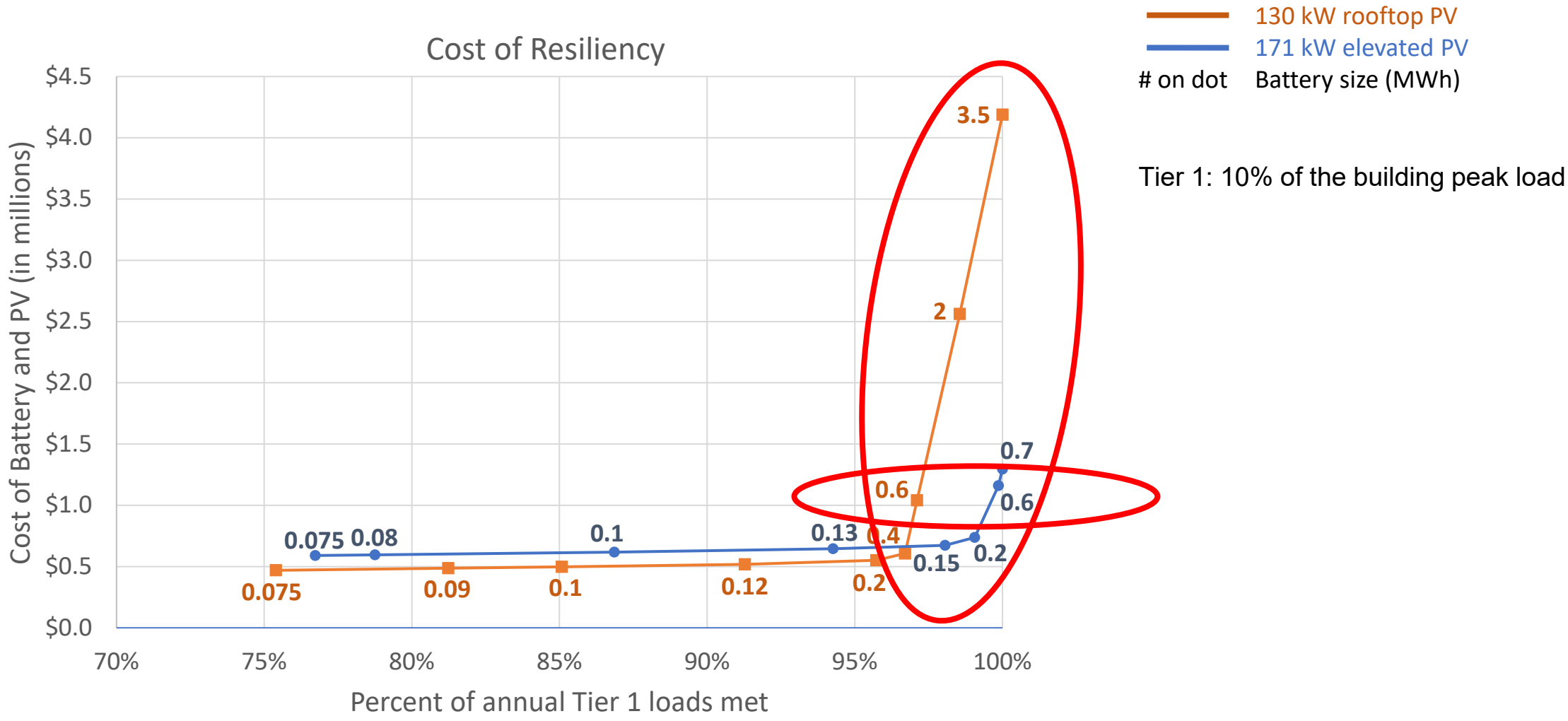



Elevated PV 171 kW




Annualized costs: DERs capital costs and utility purchase (net of exports)
NOT include EEMs or HVAC systems costs

# Indefinite coverage for Tier 1 loads



# Balancing CEC design requirements

Required space
700 ft$^2$

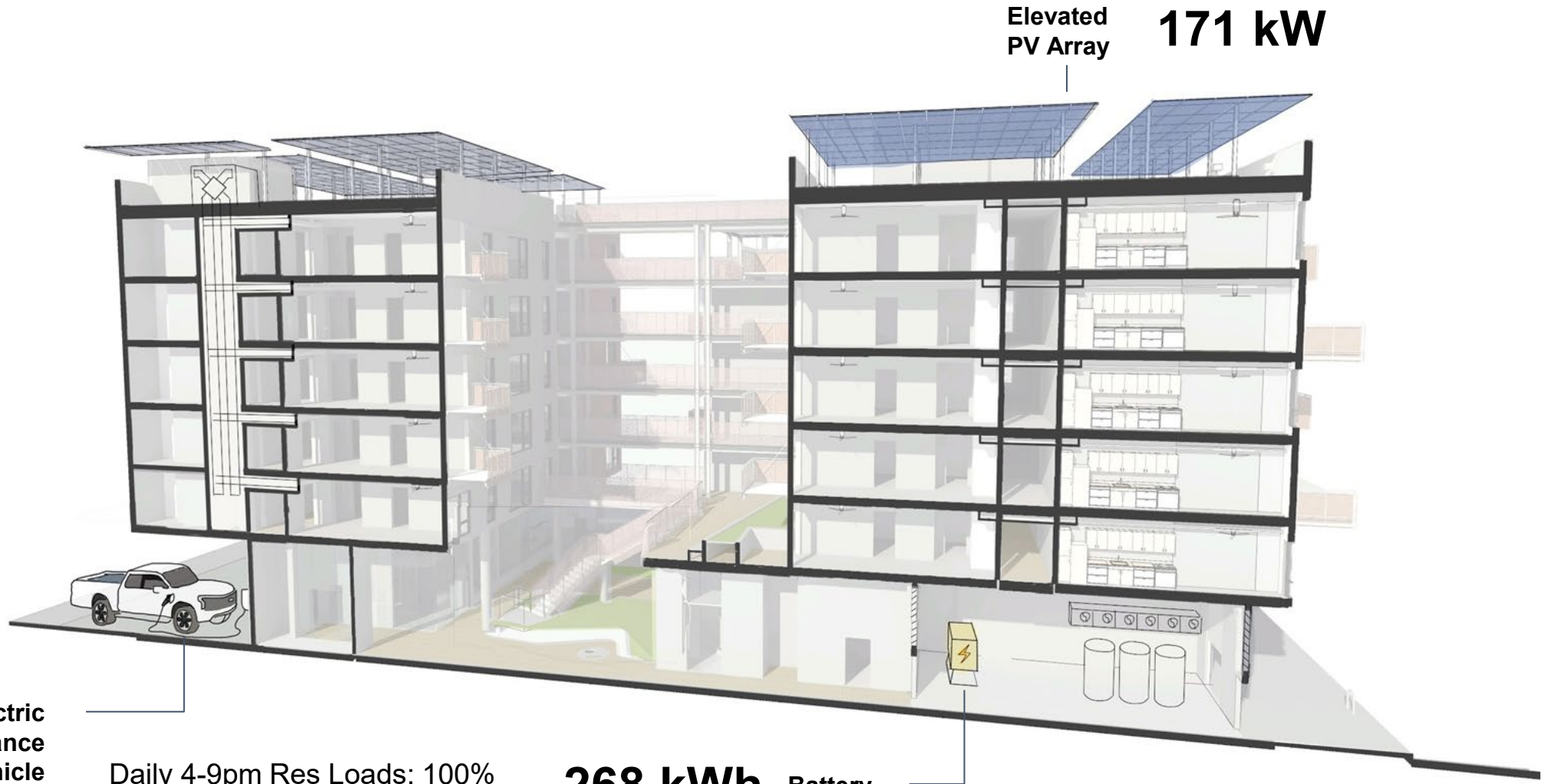
| Battery Size \| Design Req | Daily 4-9pm Res Loads | Indefinite Tier 1 Loads (10% of peak) | 24 hr Outage Tier 1&2 Loads | 72 hr Outage Tier 1&2 Loads |
|---|---|---|---|---|
| **Small: ~200 kWh** | 100% | 99% | 90% | 73% |
| **Medium: ~400 kWh** | 100% | 99.7% | 98% | 80% |
| **Big: ~ 600 kWh** | 100% | 99.9% | 100% | 90% |
| **Huge: ~1,300 kWh** | 100% | 100% | 100% | 100% |

Elevated PV Canopy, proposed energy efficiency package

**Battery Size Drivers**

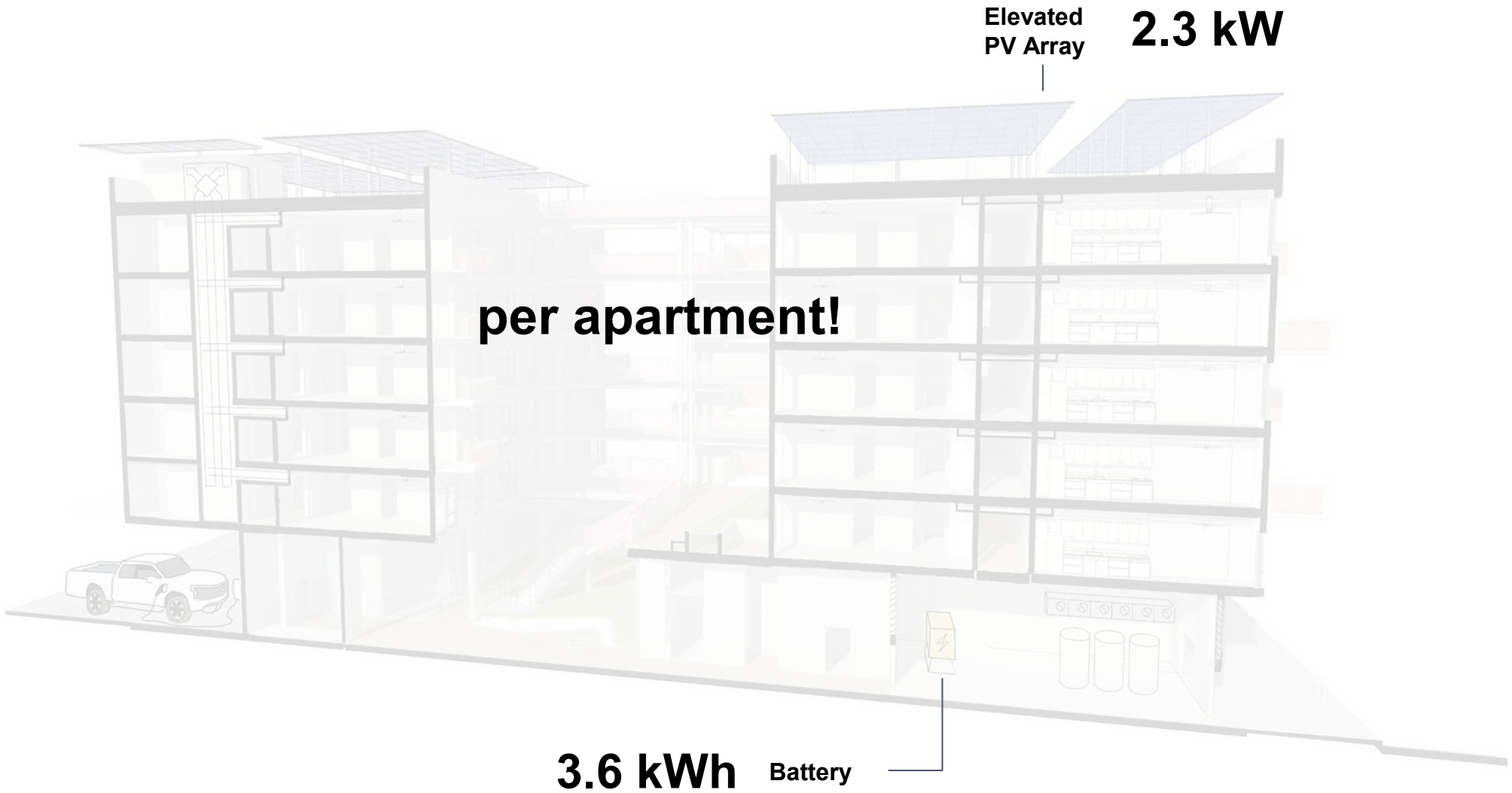
1) T1&T2 72-hr outage
2) Indefinite Tier 1 coverage
3) T1&T2 24-hr outage
4) Daily 4-9pm residential loads

# Max out PV and minimize central battery

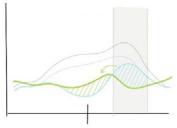
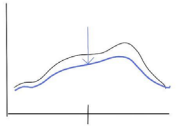
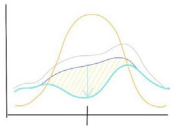



Daily 4-9pm Res Loads: 100%
Indefinite Tier 1 Loads: 99.7%
24 hr Outage Tier 1&2 Loads: 90%
72 hr Outage Tier 1&2 Loads: 73%

# Max out PV and minimize central battery



# Optimized Technology Package

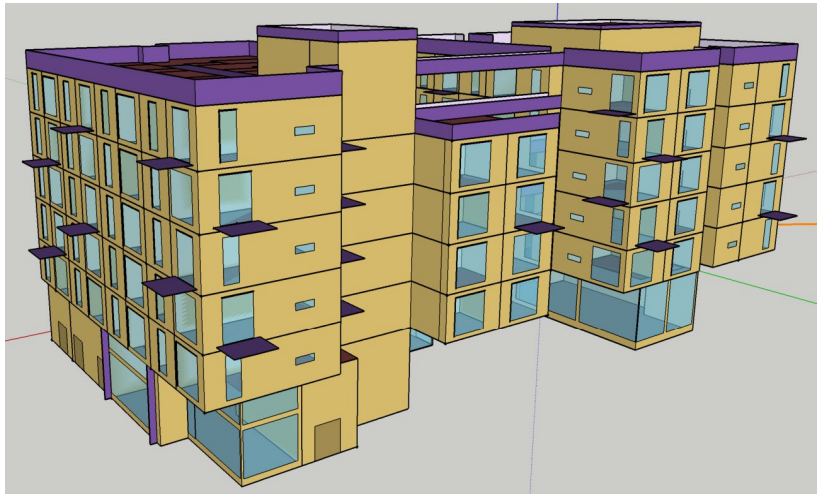
| | Strategy | Portion of Annual 4-9pm Load Served | Approximate Incremental cost |
|---|---|---|---|
|  | Thermal Storage (domestic hot water) | 32% | + $50,000 |
| | Peak Load Management | 14% | + ~ $0 |
|  | Energy Efficiency | 10% | + $250,000 |
|  | Solar PV array, Battery storage & Microgrid Infrastructure | 44% | + $2,000,000 |

$2,300,000
**$50,000,000**
**Approx. Construction Budget**

# Takeaways and next steps

## Takeaways

- Efficiency measures are key to meet goals
- HVAC loads present the greatest potential but are a small portion of the overall energy use
- Grid charging significantly reduces required DERs investment
- Meeting the critical and important load indefinitely are more challenging than meeting the entire load during grid peak hours every day



# Q&A

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