Municipal Zero Net Energy

Project Engineering as Reach Code Technical Assistance

BayREN NBI Regional Forum November 2016

Heather Larson, Green Building in Alameda County
Erik Pearson, Environmental Services Manager City of Hayward
Bruce Playle, Indigo Architects for City of Dublin Public Safety project

STOPWASTE
at home • at work • at school

BAY AREA Regional Energy Network

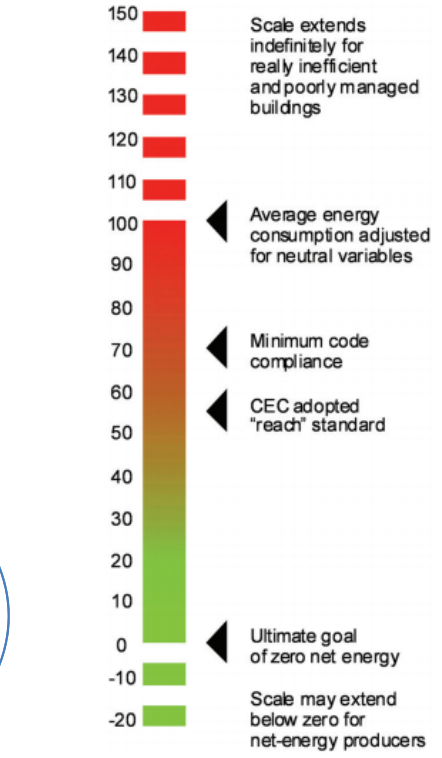
BAY AREA Regional Energy Network

Presentation Overview

- Municipal ZNE Technical Assistance
- Case Studies
  - City of Hayward- Portfolio /Policy
  - City of Dublin- Campus Project

2016 Bay REN C&S ZNE Reach Code projects led by 3 counties

- San Francisco
  - ZEPI Non-Residential Definition
- San Mateo
  - ZNE policy templates & City engagement
- **Alameda**
  - Municipal ZNE Technical Assistance
    - Engineering
    - Cost estimating
    - Portfolio review
    - Training



Green Building Grants & Technical Assistance

- **Historical Reach Codes in Alameda County (2000-2015)**
  - Prior to CAL Green State Code taking effect
    - Civic green building reach-code policies in every jurisdiction
    - Majority of jurisdictions had private sector reach code green building requirements
  - Climate Action Plans adopted in all 15 jurisdictions, first County in State

STOPWASTE
at home • at work • at school

Built Environment Services
for Local Governments
in Alameda County

Policy &
Regulatory
Support

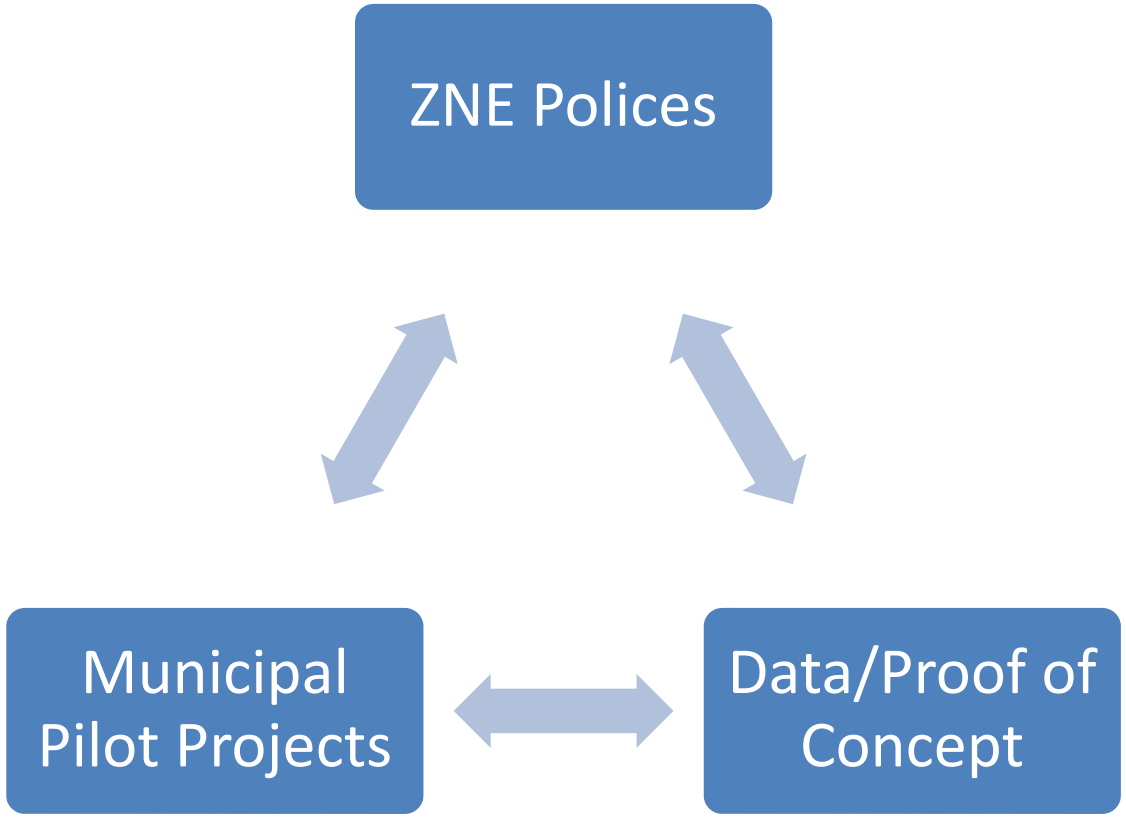
Project
Implementation
Assistance

Professional
Development
Services

County of Alameda • Alameda • Albany • Berkeley • Castro Valley Sanitary District • Dublin • Emeryville • Fremont • Hayward
Livermore • Newark • Oakland • Oro Loma Sanitary District • Piedmont • Pleasanton • San Leandro • Union City

Alameda County approach to reach codes:

Lead by Example **on municipal buildings to prime the market for ZNE policies (municipal -> commercial -> residential)**



Technical Assistance (TA) addresses lacking in-house LG engineering capacity

- Project-specific systems engineering & cost analysis to lower energy use intensities (EUI), size renewables & integrate storage
  - Modeling for optimized gas vs. electric system design
- Community scale ZNE defined by a jurisdiction's municipal energy usage portfolio
- Local government trainings (2 audiences):
  - Targeted to code enforcement staff
  - Targeted to public works, engineering & facilities staff who will be designing & operating municipal ZNE facilities

Municipal ZNE projects & policies

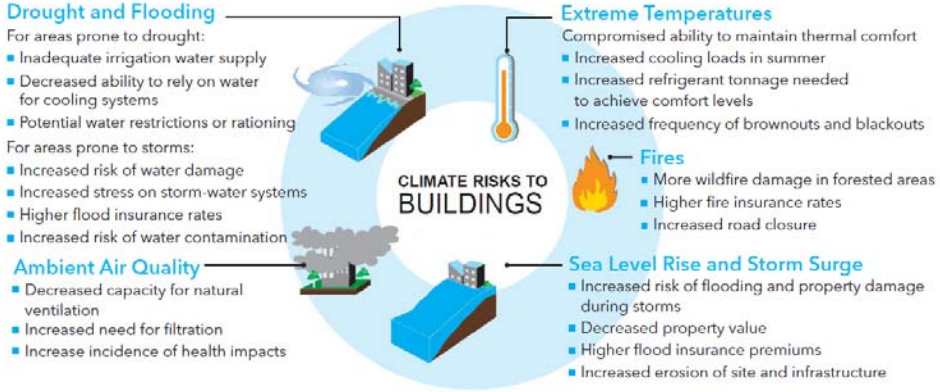
- **Receiving TA in 2016**
  - City of Berkeley
  - City of Dublin- Campus project case study
  - City of Hayward- Policy/Portfolio project case study
  - City of Oakland
  - County of Marin
  - City of West Marin
  - County of Alameda
- **To Request Municipal ZNE Engineering assistance in 2017 email: codes@bayren.org**

Oakland Dispatch Center

- Net Zero Analysis
- Define ZNE
- Recommend EE Measures
- Consider Fuel Switching
- Size Solar PV System

The Oakland 911 Dispatch Center in Oakland, California is approximately 11,700 square feet dispatch facility. The scope of the net zero feasibility analysis only includes the single building.

Berkeley Recreation Center



B-READY

- Energy & Resiliency analysis
  - Sports lighting LED retrofit
  - Heating system fuel switch
  - Heat Pump hot water heaters
  - Induction range
  - LED lighting replacement
  - BMS system
  - Roof insulation
  - Natural Ventilation upgrades
  - Battery Storage
  - Solar PV System

BAY AREA Regional Energy Network

City of Hayward

City staff working on Municipal ZNE ordinance adopted 2016

BAY AREA Regional Energy Network

ZNE Library Under Construction

City of Hayward General Plan Policy

NR-4.10 Public Renewable Energy Generation:
The City shall ensure that all new City-owned facilities are built with renewable energy, as appropriate to their functions, and shall install renewable energy systems at existing facilities where feasible.

City of Hayward passed a Municipal ZNE Ordinance April 2016

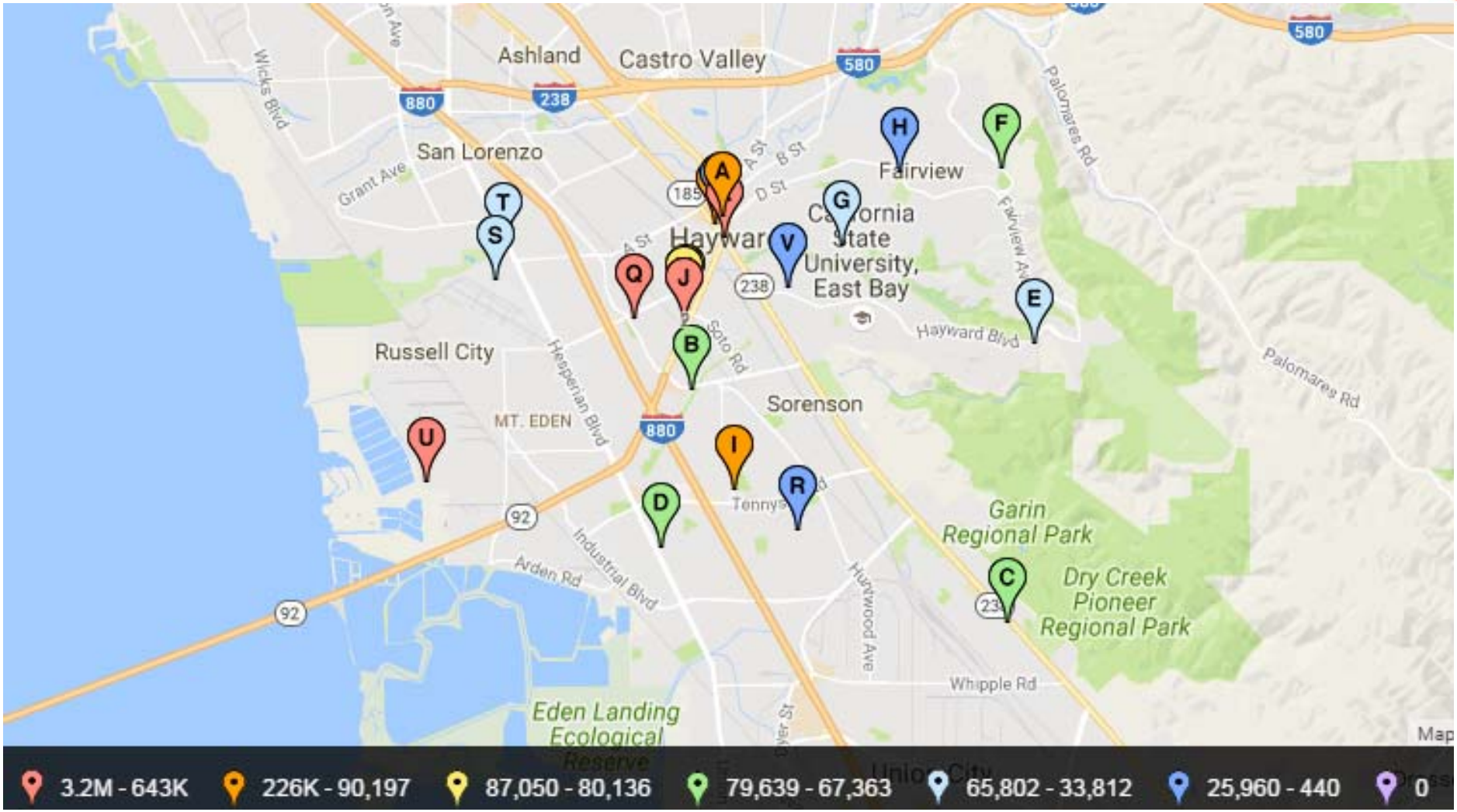
- City of Hayward is 1 of 3 total jurisdictions in CA w/ a ZNE ordinance as of Q3 2016 (Santa Barbara & Palo Alto)
- Community Scale ZNE for Municipal Portfolio
- Current municipally owned generation (Solar + co-gen at wastewater treatment plant = 12,387,000 kWh per year) meets ~1/2 of municipal energy usage

NOW, THEREFORE, BE IT RESOLVED by the City Council of the City of Hayward that all new City buildings that begin design after January 1, 2017, shall be zero net energy; and

BE IT FURTHER RESOLVED that all existing City buildings for which renovations exceeding 50% of the building's value and that begin design after January 1, 2017, be zero net energy; and

BAY AREA Regional Energy Network

City of Hayward



City of Hayward

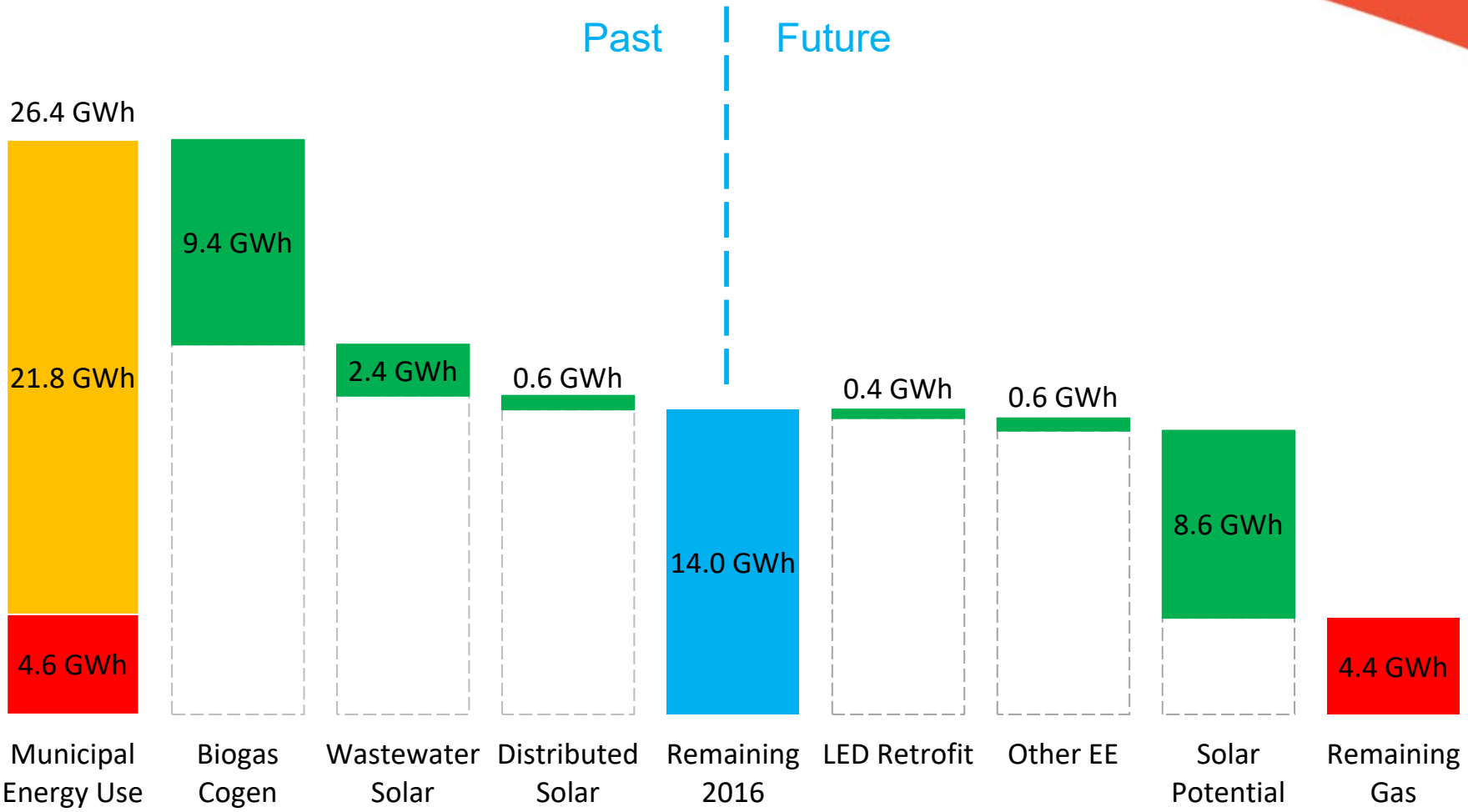
Summary of assistance on ordinance

- Can we go full Municipal ZNE by 2025?
  - Can we do it sooner?
- Validate solar potential assumptions
- Is it cost effective?
- What rate tariff?
- How to deal with Gas?

BAY AREA Regional Energy Network

Renewable Energy at Hayward's Water Pollution Control Facility

City of Hayward



What about remaining gas load?

Install a 2nd Cogeneration Engine

Electrify Municipal Buildings

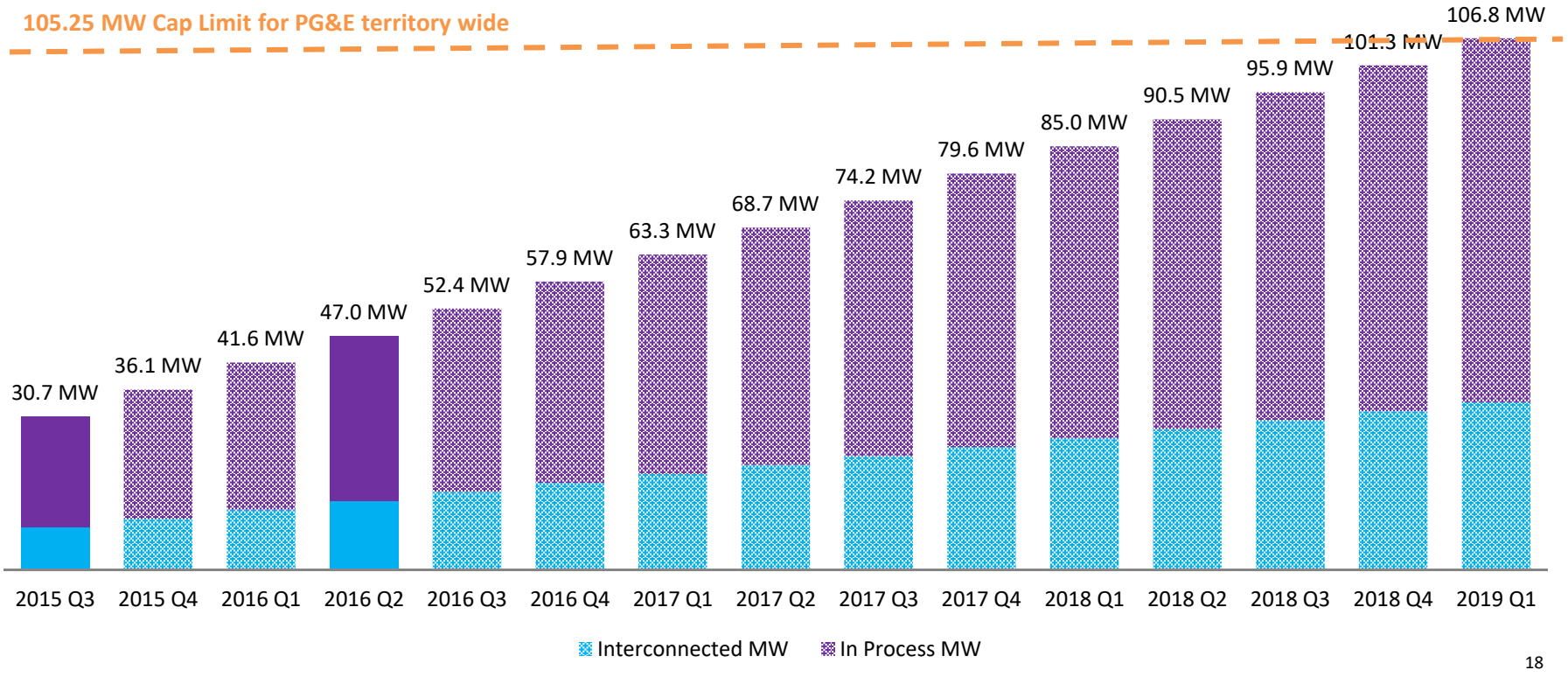
Wheel Gas through PG&E Piping

Truck to CNG Storage Tanks

Create CNG Vehicle Fuelling Station

Bill Credit Transfer Analysis

Should we actually be aiming for 2020?



City staff generation analysis

BAY AREA Regional Energy Network

	Description	Address	Square Feet	kW	kWh/year	2015 Usage (kWh)*
1	Police Station	300 West Winton Avenue	23,000	345	604,440	929,718
2	Muni Lot (A, B, Main, Mission)	22550 Mission	10,000	150	262,800	
3	Muni Lot (Foothill, A, Main, B) - access from A St.	1025 A St.	12,500	188	328,500	
4	Muni Lot (Foothill, A, Main, B) - access from B St.	1042 B, & 5 more APNs	20,000	300	525,600	
5	Muni Lot (B, C, Foothill, 2nd)	Foothill & B	16,000	240	420,480	
6	Muni Lot (Maple Ct. & A St.)	22456 Maple Ct. (north half)	16,750	251	440,190	
7	Muni Lot (Foothill, Russell, 2nd, A)	Foothill & A	12,000	180	315,360	
8	Cinema Parking Structure	22695 Foothill	10,100	152	265,428	68,126
9	Barnes Ct. bldg (add more on roof)	16 Barnes Ct.	7,000	105	183,960	
10	Barnes Ct. (carport to replace tent at rear of site)	16 Barnes Ct.	4,500	68	118,260	
11	Fleet Bldg.	24505 Soto Road	2,600	39	68,328	80,950
12	Fire Station 1 (assuming carport - roof doesn't look good)	22700 Main Street	5,400	81	141,912	141,457
13	Fire Station 2	360 West Harder Rd	1,000	15	26,280	35,732
14	Fire Station 3	31982 Medinah St	550	8.3	14,454	33,066
15	Fire Station 4	27836 Loyola Ave	650	9.8	17,082	36,413
16	Fire Station 5	28595 Hayward Blvd	880	13.2	23,126	40,810
17	Fire Station 6	1401 West Winton Ave	1,500	22.5	39,420	120,938
18	Fire Station 7	28270 Huntwood Ave	2,000	30.0	52,560	
20	Fire Station 9	24912 Second St	600	9.0	15,768	30,373
21	City Hall	777 B St.	4,190	63	110,113	1,191,355
22	Watkins Street Parking Structure (2nd half)	Watkins & B	14,600	283.0	495,816	
23	2nd CoGen engine at WPCF	3700 Enterprise Way		800	7,008,000	
24	Phase 2 Solar PV at WPCF	3700 Enterprise Way		1,000	2,352,936	
25	Hesperian Pump Station - roofed canopy	28471 Hesperian Bl	11,000	165	289,080	169,160
26	Walpert pump reservoir/station	1241 Walpert St.	7,500	113	197,100	262
27	500 Reservoir	1910 Highland Blvd	4,700	71	123,516	796,462
28	750 Reservoir	26633 Parkside Dr	7,500	113	197,100	740,618
29	1000 Reservoir	3466 La Mesa Drive	1,200	18	31,536	456,309
30	1285 Reservoir	28750 Fairview Ave	2,600	39	68,328	290,520
31	May Road (adjacent to Treeview Reservoir)	087-0040-004-04	20,000	300	525,600	
32	Garin Reservoir	083-0464-024-00	6,800	102	178,704	
33	Emergency Well E (Old Well 9)	28251 Industrial Bl	1,300	20	34,164	
34	Mohrland Emergency Well	24927 Mohr Dr	5,300	80	139,284	
			233,720	**5,025**	**15,615,226**	

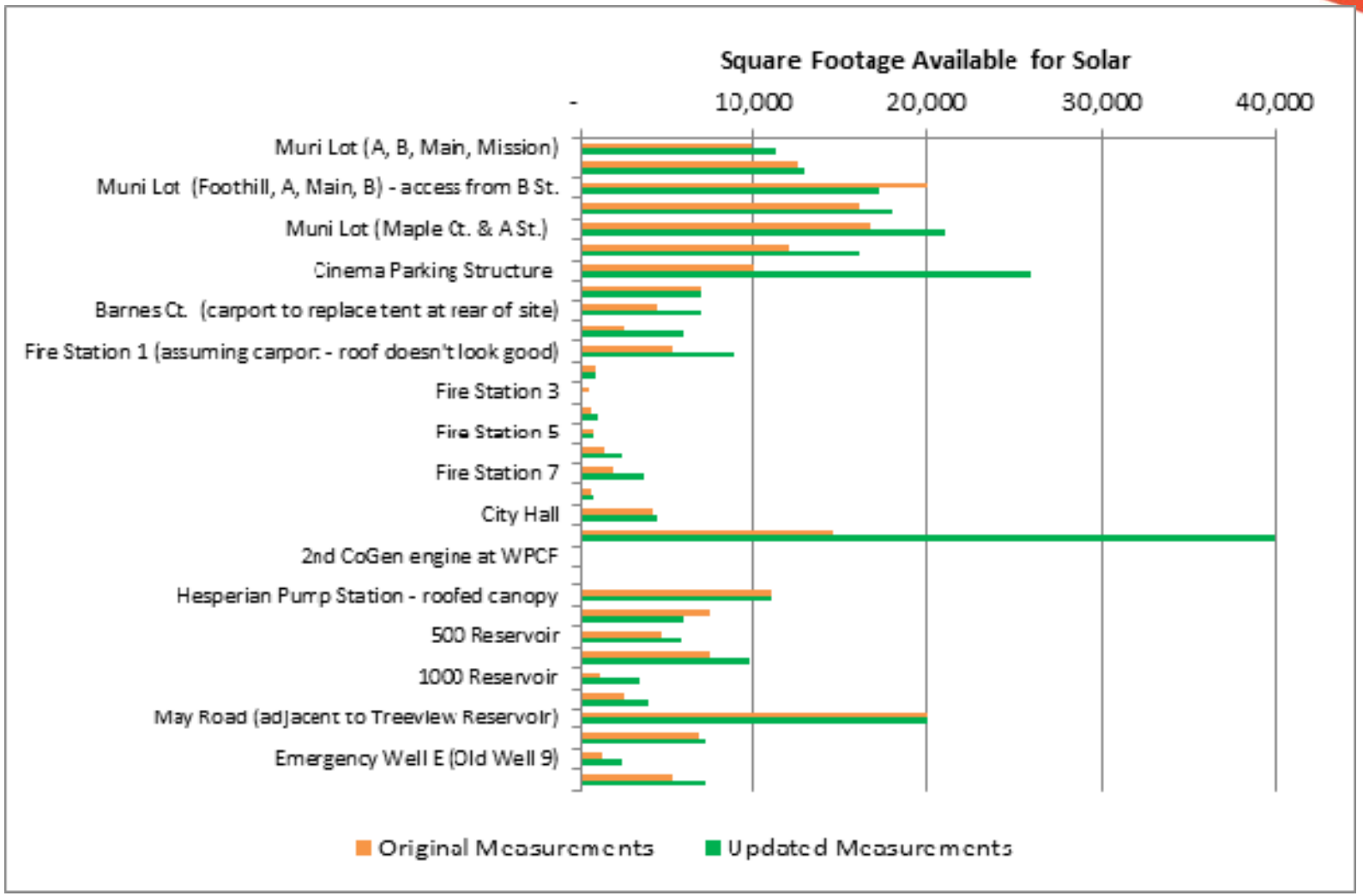
Additional Possiblities:
Airport Property
Area between City Hall and BART
Centenial Hall Parking Structure

kWh needed to zero out electricity use: 9,392,958
Difference: 6,222,268

kWh needed to go carbon neutral (incl. nat gas): 13,997,460
Difference: 1,617,765

Solar Potential

Refinement of generation analysis



City of Dublin –

Project Architect for Public Safety Complex

BAY AREA Regional Energy Network

City of Dublin Public Safety Complex

BAY AREA Regional Energy Network

Façade with 50's styling….

…and old school single-glazing

BAY AREA Regional Energy Network

Sustainability goals

- This public facility will be designed, built and operated using green building principles demonstrating leadership by example.
- Visible public projects that highlight the beauty and value of green building, raise awareness, encourage the private sector to build green.
- Promote local market transformation by demonstrating best practices in government owned buildings.

Resiliency goals

- Building must adapt to emergency conditions, quickly regaining functionality during and long after disaster or power outages.

- Conserve energy usage to extend e-power system availability, reduce amount of PV required for ZNE offset.

- Take advantage of resilient measures for LEED compliance and to improve the daily work environment. Examples:

    - Natural lighting.
    - Natural ventilation.

Zero Net Energy

- BayRen/ DNV GL came in during schematic design phase.
- Presentation to Dublin City Council, ZNE defined.
- Recommended Energy Conservation Measures.
- Helped predict energy use.
- Reviewed potential funding sources.
- Helped integrate the ZNE work with LEED, CalGreen and PG&E Savings-by-Design program.

Recommended ECMs

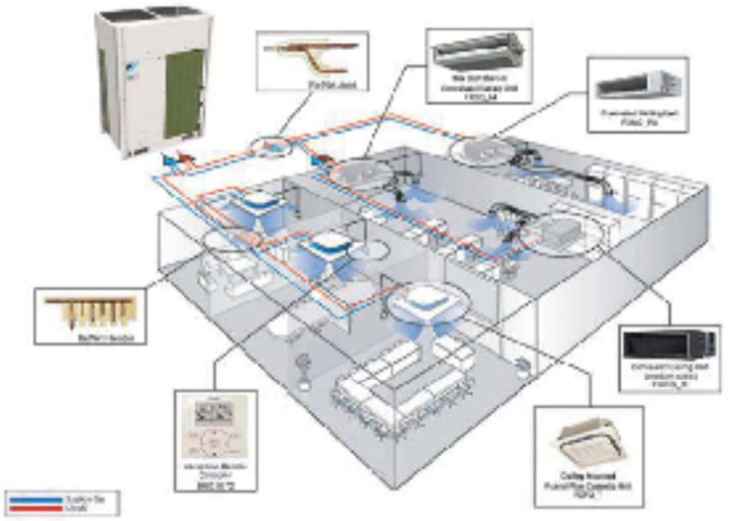
Heat Pump Water Heater with COP ← DHW System | HVAC System → Variable Refrigerant Flow (VRF)

Typical domestic hot water systems include electric water heater or natural gas water heater, including an expansion tank, which incur standby loss. Heat Pump Water Heater (HPWH) is an emerging technology that extracts heat from air to heat the water. Due to its high efficiency, it is recommended instead of electric tank-less water heater. Even federal regulation requires heat pump water heater where electric heaters are to be installed in commercial facilities where the rated storage volume are above 55 gallons.

	Electric Water Heater	Natural Gas Water Heater	Heat Pump Water Heater
Efficiency (COP)	0.86 - 1	0.7 - 0.82	2.0 - 2.4
Advantage	Easy to install, Safer, Lower Capital Cost	Faster Recovery Rate, Convenient for Larger Load	Highest Efficiency
Disadvantage	More Costly where Electric Prices are Higher	Lower Efficiency	May Require Isolation from Conditioned Heated Areas

Water Heaters Comparison

Heating, Ventilation, and Air Conditioning (HVAC) system is one of the major end use consumptions. Selection of specific system is critical to the overall system efficiency and energy performance. A variable refrigerant flow (VRF) system with heat recovery is typically a three pipe system that have the ability to simultaneously heating certain zones and while cooling others, yielding the efficiency up to 14 EER.

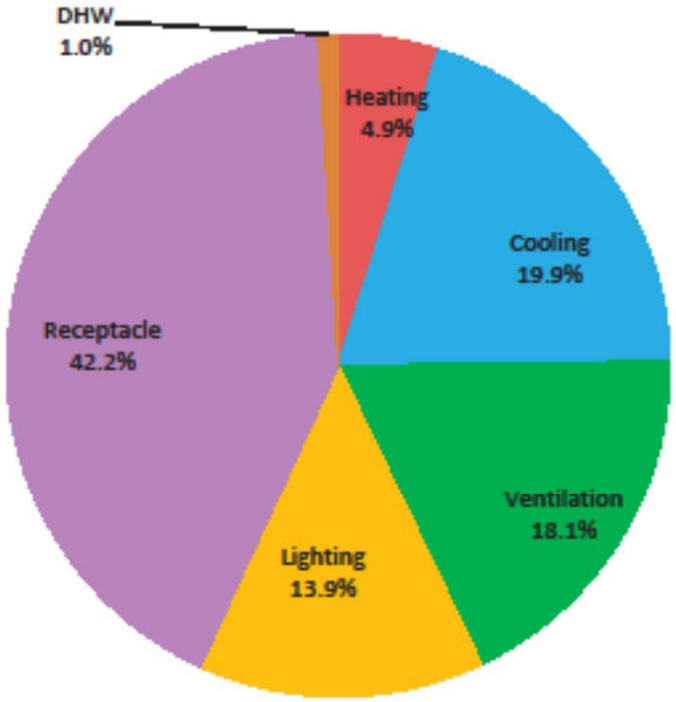


Variable Refrigerant Flow System Diagram

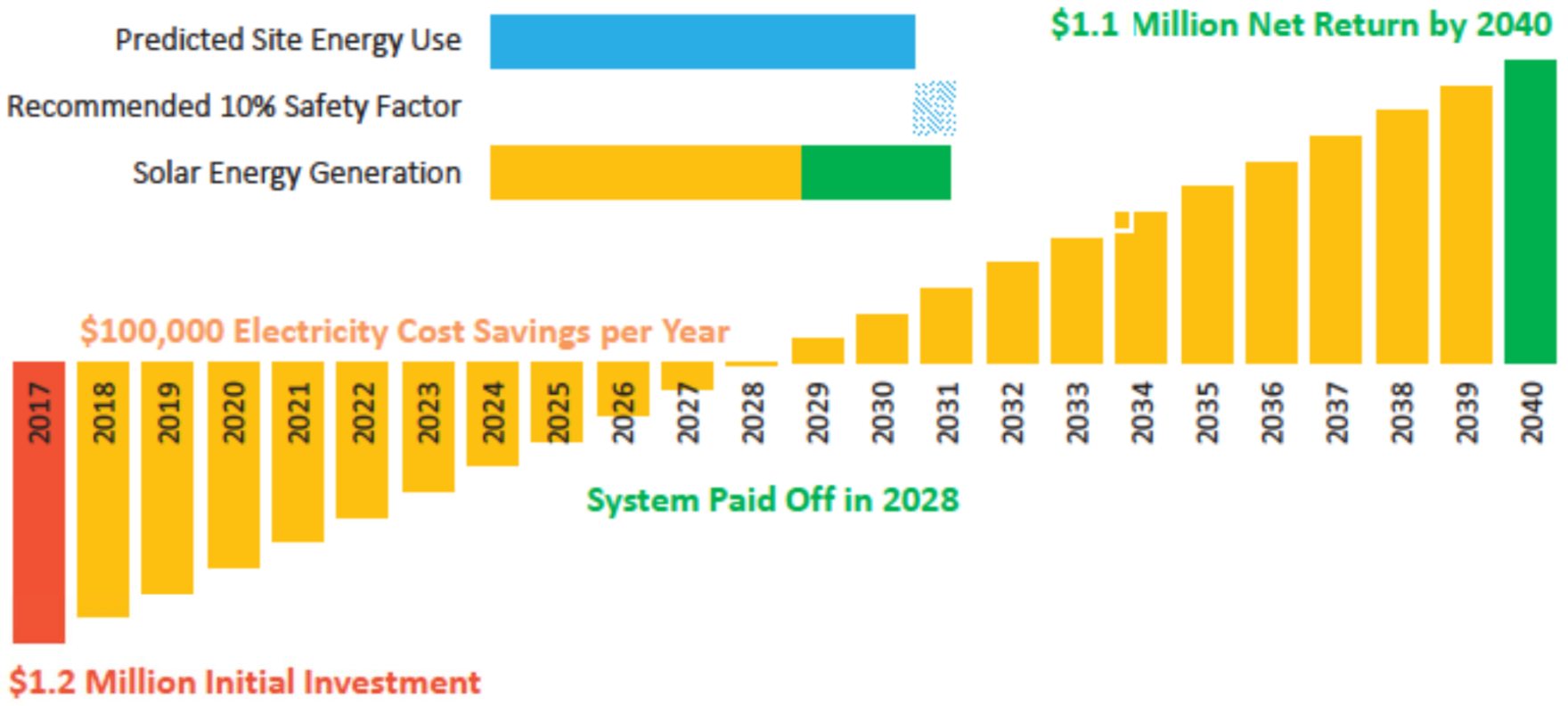
Predicted Energy Use

An energy model was created using information available from the design team, including: drawings, schedules, and predicted occupancy. The Trane TRACE 700 energy simulation engine to predict annual energy use. The results are outlined in the tables and chart below, and are used to size the renewable energy systems for the project.

Predicted Annual Energy Use		
End Use	**Energy Use**	**EUI (kWh/SF/yr)**
Heating	23,581 kWh	0.7
Cooling	95,808 kWh	2.7
Ventilation	87,234 kWh	2.4
Lighting	67,119 kWh	1.9
Receptacle	203,263 kWh	5.6
DHW	4,674 kWh	0.1
Total	**481,680 kWh**	**13.4**



Renewable Lifecycle Cost Analysis



BAY AREA Regional Energy Network

Carport mounted

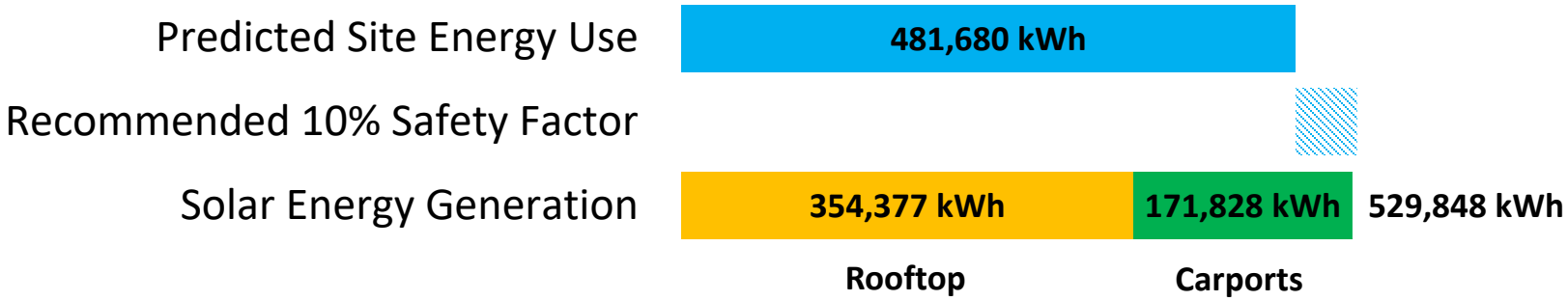
Roof mounted

Overview of roof and carport PV

BAY AREA Regional Energy Network

ZNE defined, measures adopted

Definition



Measures

- Window glazing replacement
- Solar shading louvers
- Daylighting system including LED fixtures
- High-efficiency heating & cooling system (VRF)
- Heat Pump Hot Water
- Photovoltaics

BONUS!: Solar on adjacent tenant space connected to police station meter, tenant can utilize 10% excess generation capacity….

BAY AREA Regional Energy Network

New entry element built with straw bales, a renewable resource.

BAY AREA Regional Energy Network

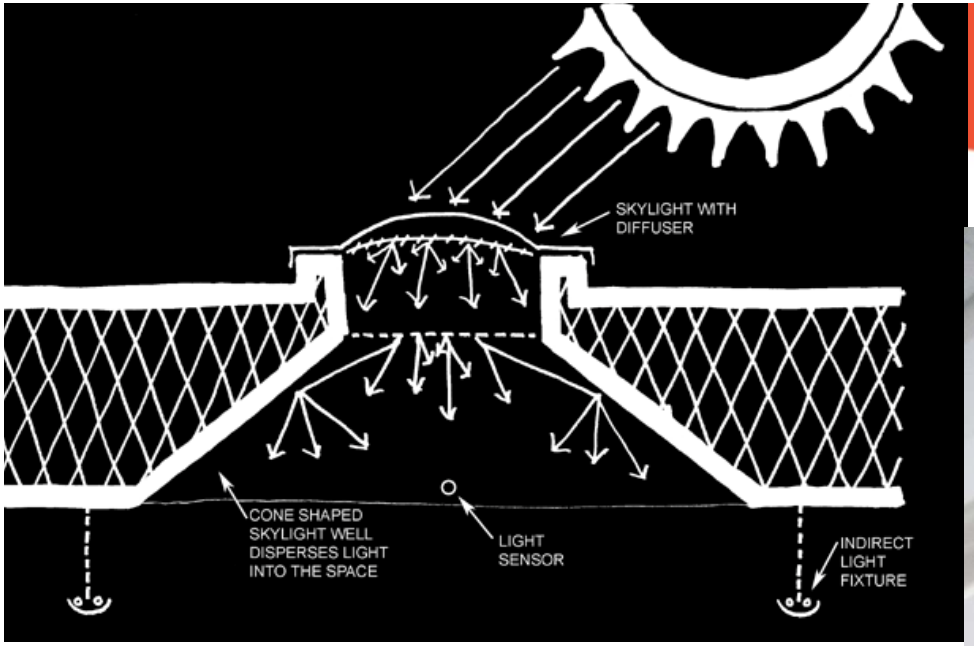
Welcoming service point for police services… legible and accessible to the community

Step 1

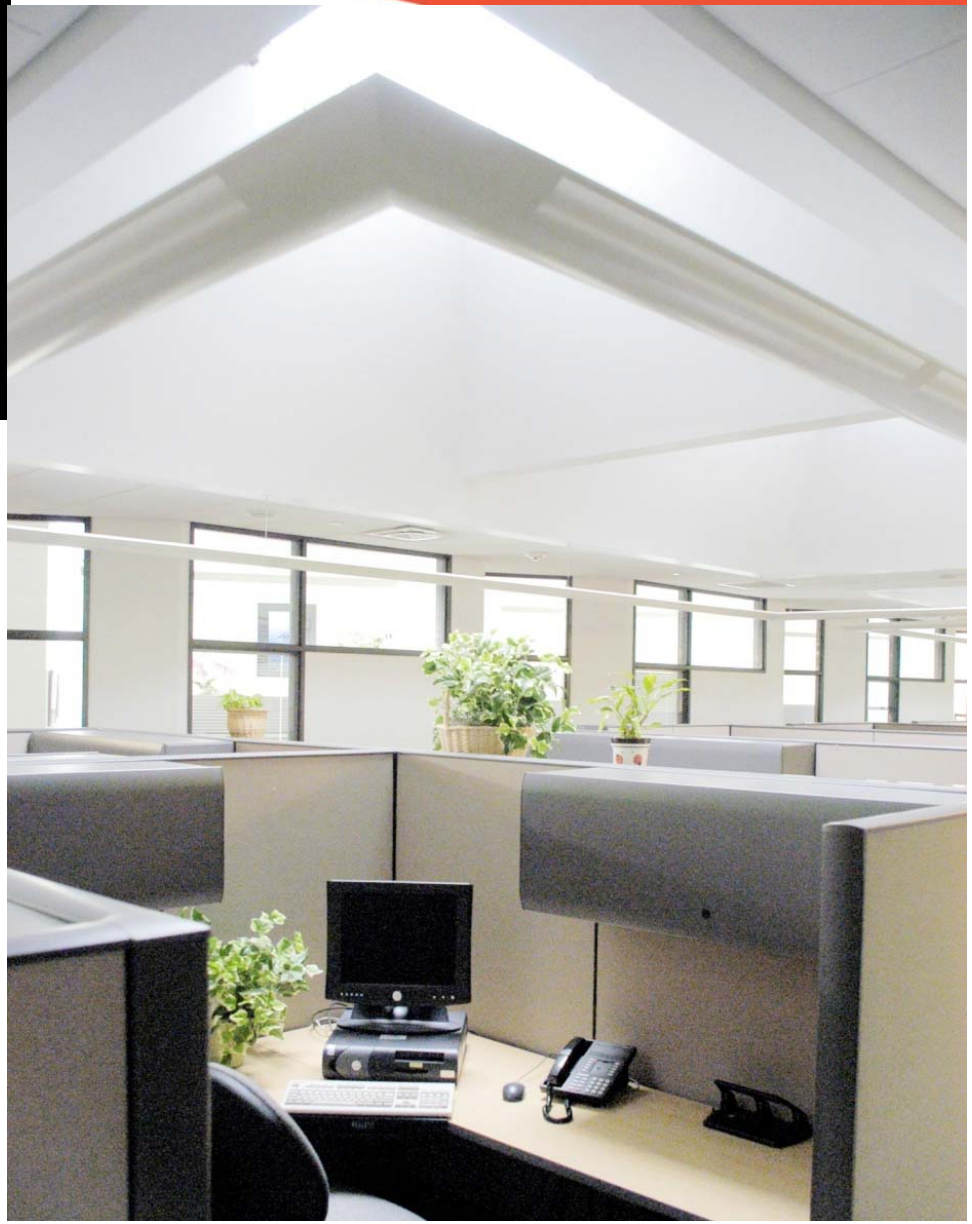
Finished! Strawbale R-40

Step 2

Step 3



BAY AREA Regional Energy Network

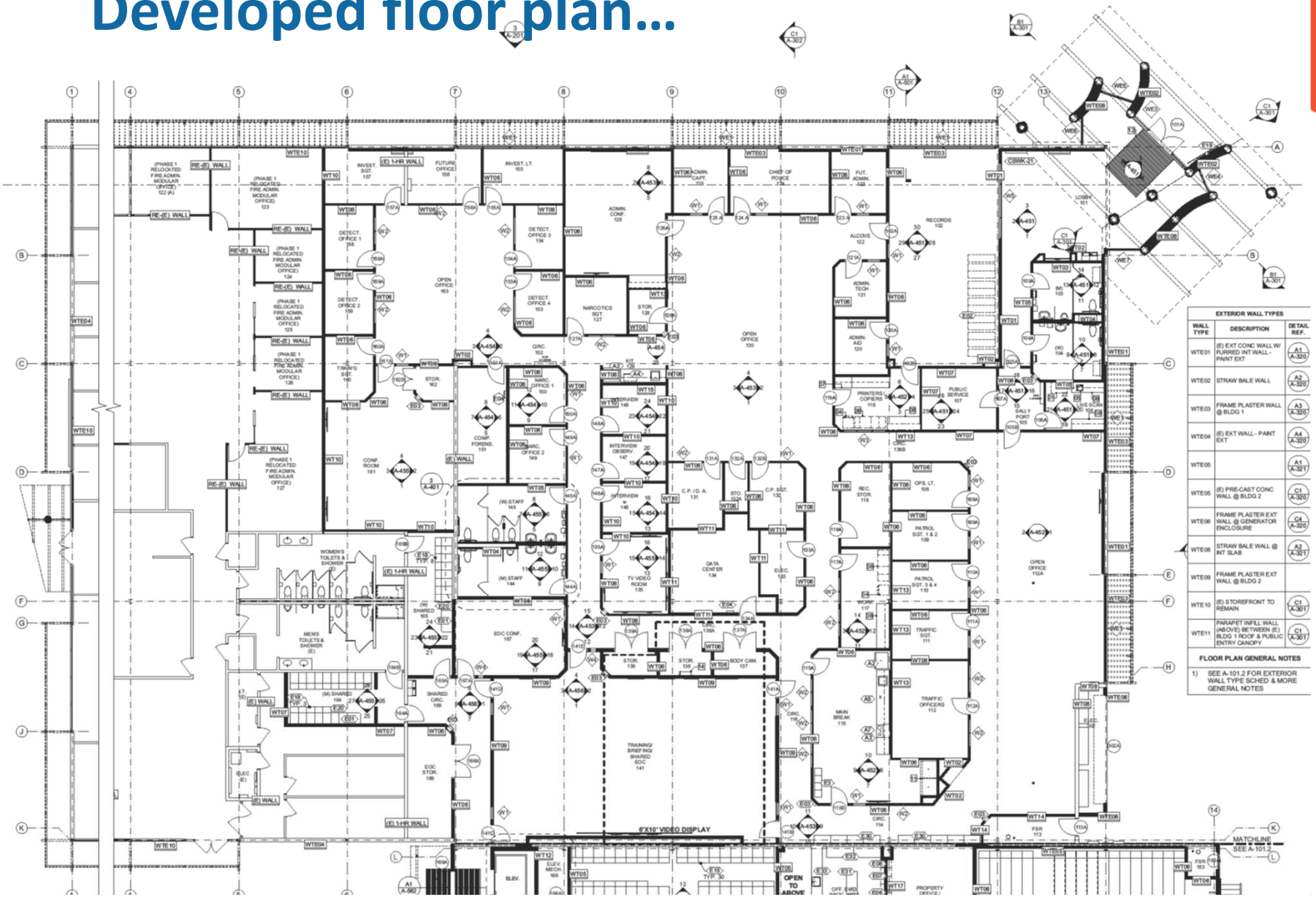


Daylighting

Schematic floor plan…

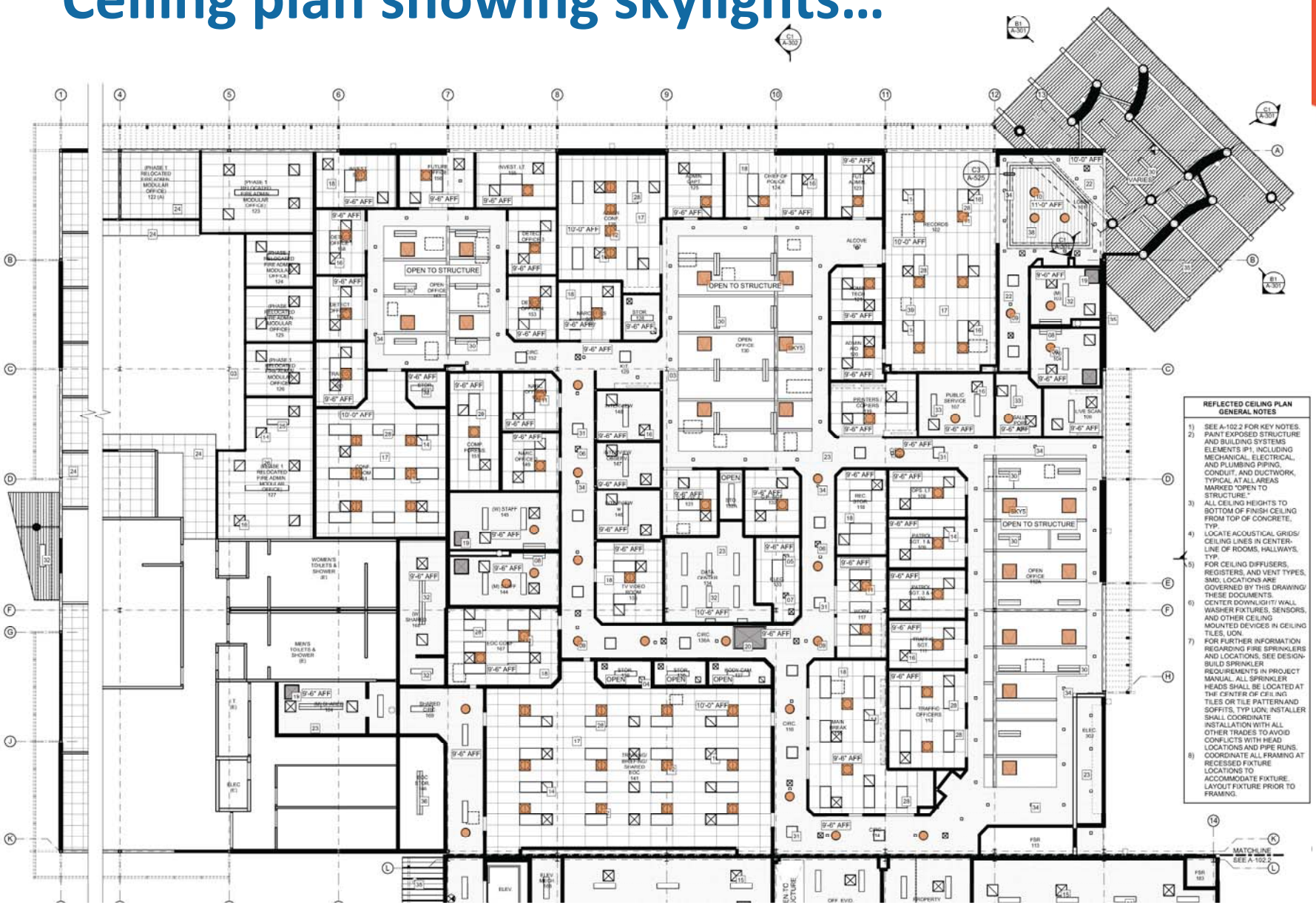
BAY AREA Regional Energy Network

Developed floor plan…

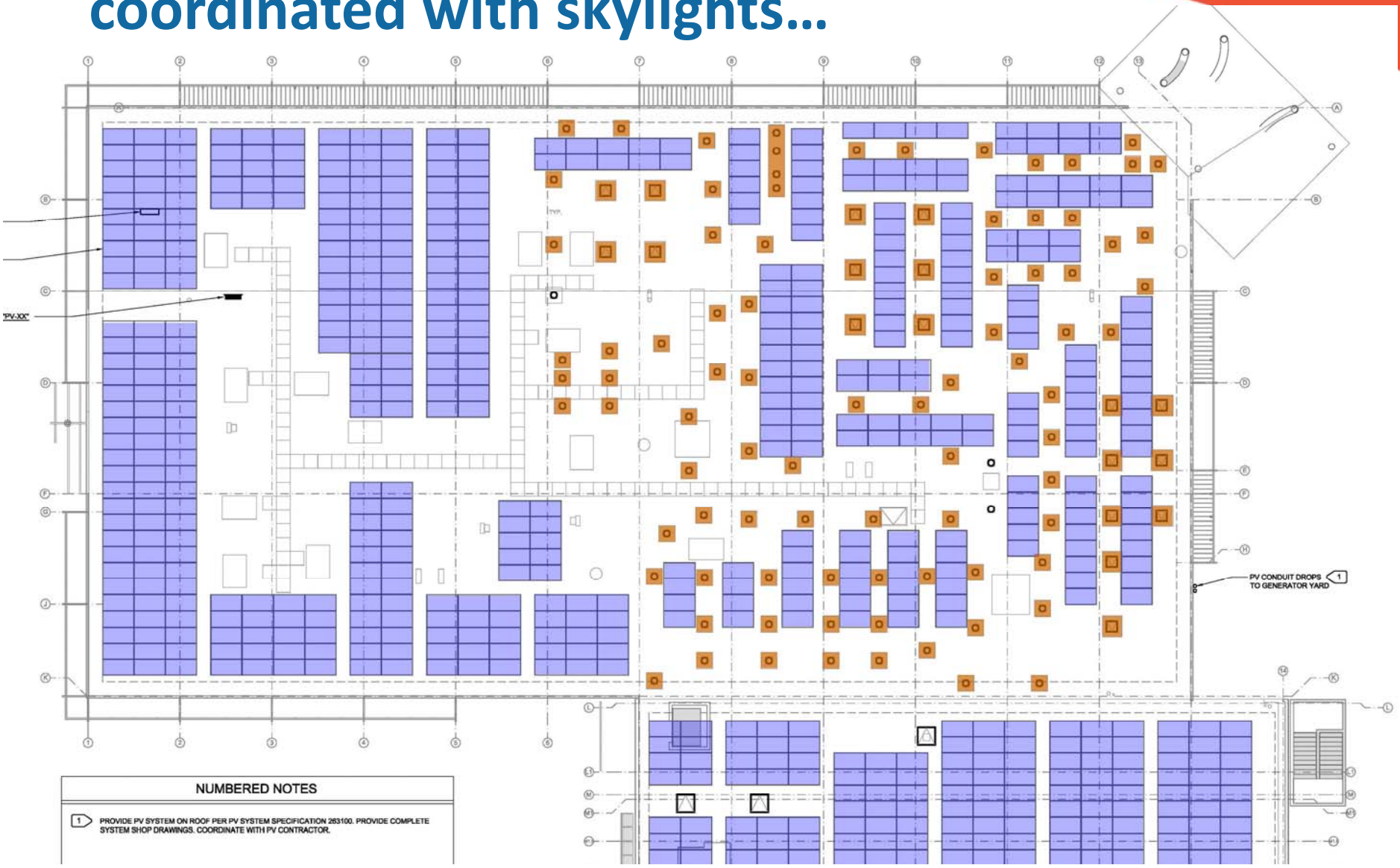


BAY AREA Regional Energy Network

Ceiling plan showing skylights…



Roof plan showing PV coordinated with skylights…



Planned ZNE installation…

BAY AREA Regional Energy Network

Project Status and Financing Options

- Project now in final design, bids due in mid-February. ZNE photovoltaics are a bid alternate estimated at $1.1 million, paid for by project funds.

- General Contractor would be responsible for integrating into the project, panels City-owned.

- City has options. It can accept the bid alternate, or
  - proceed with a standalone PV bid,
  - switch to a power purchase agreement (PPA),
  - go for an Energy Saving Performance Contract (ESCO),
  - other.