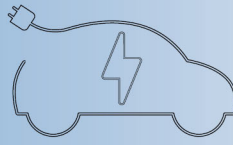


**California Department
of General Services**

*Southern California
Consolidation Project
Riverside, California*

AIR RESOURCES BOARD



Getting to Zero National Forum

*Scaling Up; Insights from the New CARB Zero Energy
Emissions Testing and Research Facility | October 11, 2019*

A DESIGN-BUILD PARTNERSHIP



HENSEL PHELPS
Plan. Build. Manage.

ZGF



**Affiliated
Engineers**

1

INTRODUCTION

CARB's Mission



2

INTRODUCTION

CARB's Mission



3

INTRODUCTION

CARB's Impact



4

INTRODUCTION

CARB's Impact



Cars in general are 99% cleaner than in 1970s



1960s: PCV valve Positive Crankcase Ventilation
 1970s: The catalytic converter NO_x—smog “precursor”
 1990s: “Check engine light” OBD (On Board Diagnostics)
 2010s: VW Defeat Device, \$33B cost to VW and counting

5

INTRODUCTION

CARB's New Headquarters



6

INTRODUCTION

CARB's New Headquarters



Ken Calvert, Mark Takano, Mark DeSaulnier and 6 others

1 29 40



Mary Nichols @MaryNicholsCA · Oct 27

Single largest **#netzero** energy structure in US, new state-of-the-art SoCal HQ builds on the legacy of **#HaagenSmit** lab & will provide CARB with tools & technology to continue to lead the **#cleanair** fight for generations to come!
[#CARB50 buff.ly/2y9ZWaU](https://buff.ly/2y9ZWaU)

Design-Build Competition Stipulated Sum Contract

- 3.5 Years for Design-Build
- 18.8 Acre Site
- 402,000 SF Building
- 3.5+ MW Solar Panels
- 1.5 MWh Battery
- 110 Vehicle Chargers
- Largest On-Site Zero Energy (ZE) Building in US
- CALGreen Tier 2
- LEED Platinum®
- Air Quality Mandates
- HFO Refrigerants

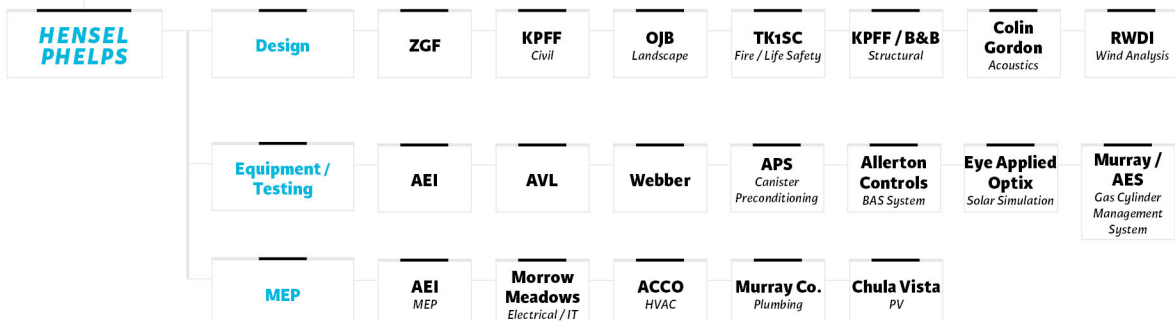
7

THE BASICS

Design Build Team

AIR RESOURCES BOARD

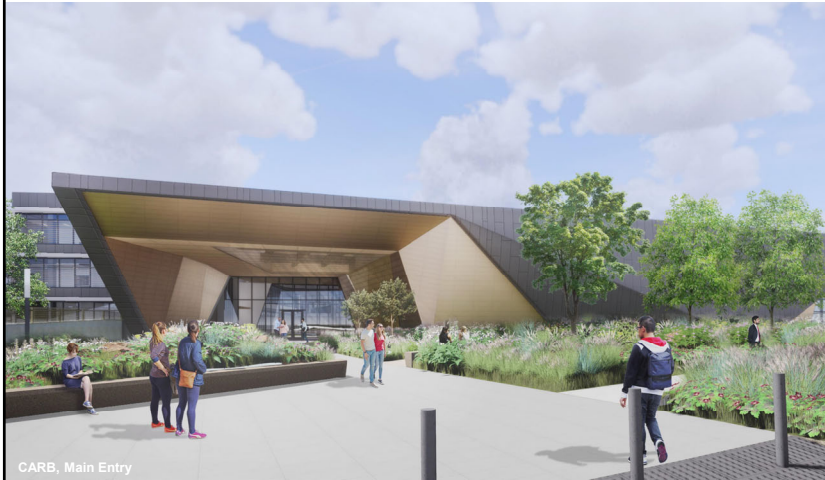
California Department of
General Services



8

THE BASICS

Project Goals and Challenges



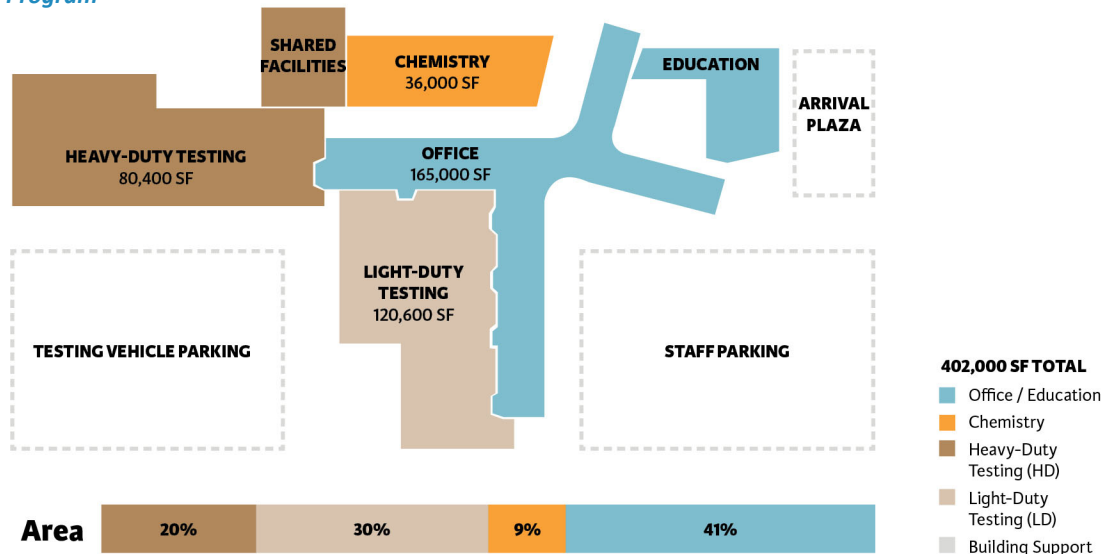
Scaling Up:

- A New Identity for CARB
- Unique, Complex Program
- High-Quality Construction
- Budget, Time & Site Constraints
- Prioritizing for Best Impact
 - On-Site Generation for ZE
 - All-Electric Design
 - Passive Design Strategies
 - Thermal Energy Storage
 - Battery Storage
 - EV Charging

9

THE BASICS

Building Program



10

THE BASICS

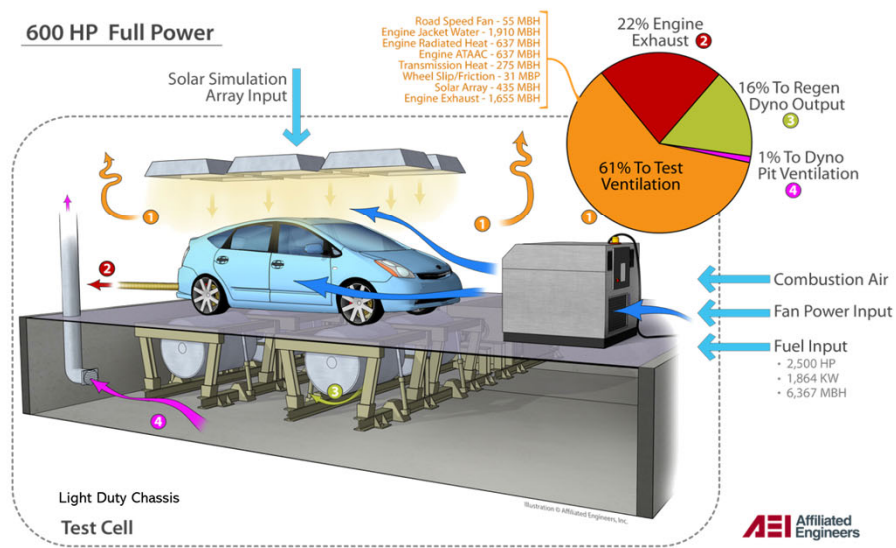
Building Program – Vehicle and Engine Test Cells



11

THE BASICS

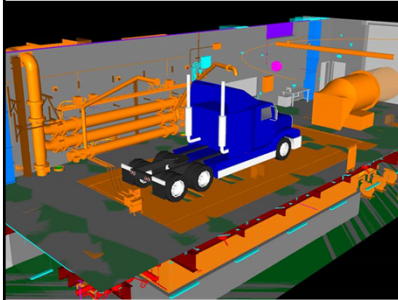
Building Program – Vehicle Test Cells



12

THE BASICS

Building Program – Heavy Duty Chassis Testing



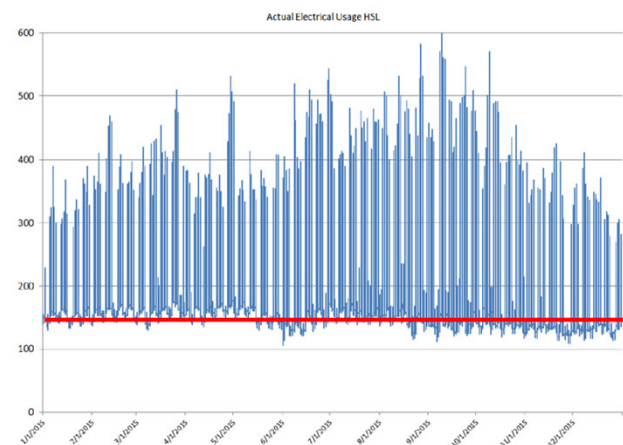
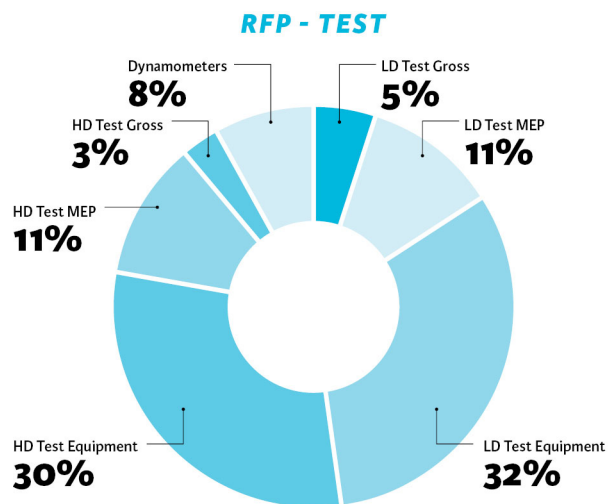
Heavy Duty Chassis Emissions Test Cells

- Two Emissions Test Cells
- 4WD (4x2 Dyno) rated for 14,000 to 100,000lb Gross vehicle weight, on-road and off-road
- Class 4 to class 8 trucks, including full size buses
- 25% of testing done to class 4-6. class 7-8 is 38% and road-to-laboratory is 37%

13

THE BASICS

RFP Benchmarks: Metering and Scaling Up



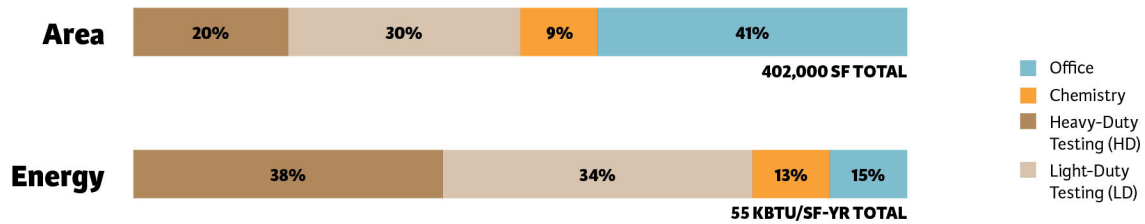
14

THE BASICS

Building Program and Energy Usage

—

Proportion of Program Area and Energy Use

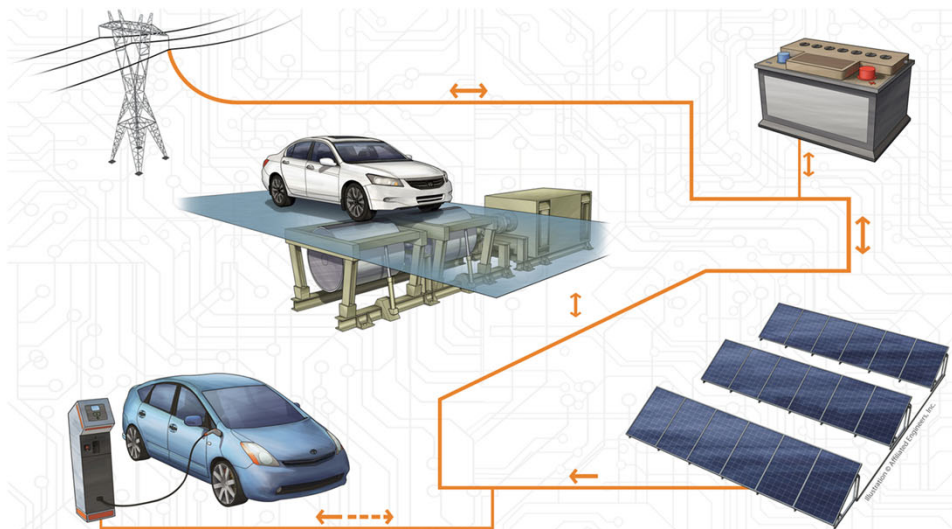


15

THE BASICS

Electrical Systems Supporting the ZNE Solution

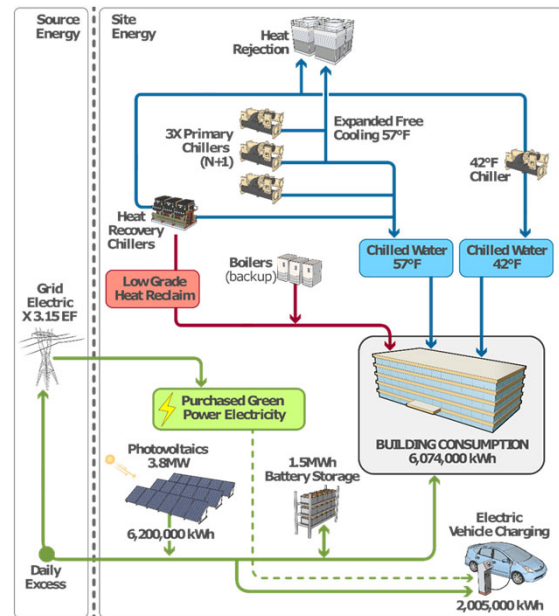
—



16

THE BASICS

ZNE Analysis Tools and Design Concept



17

THE BASICS

Concept Aerial View



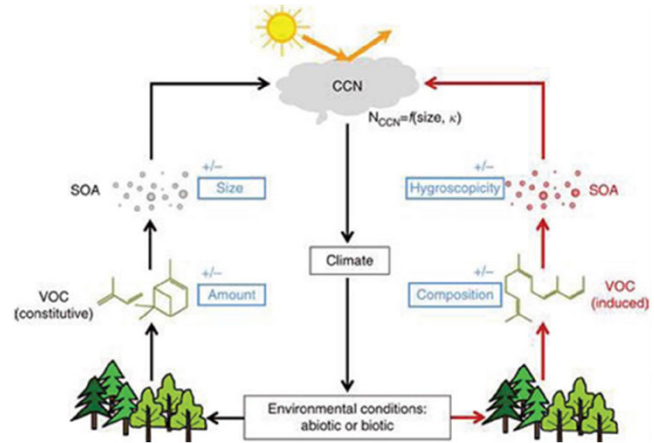
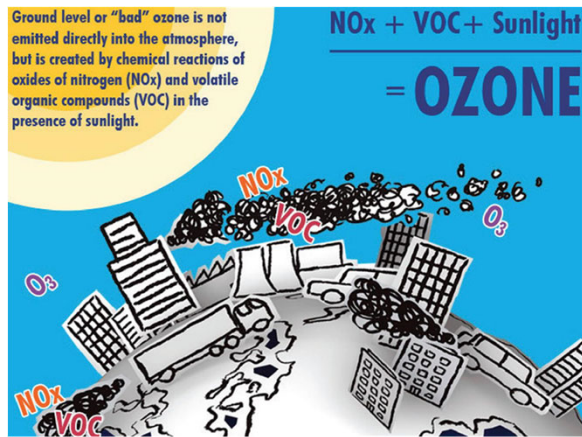
18

BALANCING PROGRAM AND ZERO CARBON

Biogenic Emissions: BVOCs from Plants and Trees

BVOC Biogenic Volatile Organic Compounds = Leaf Mass + Emission Factors + °F + Light

SOA Secondary Organic Aerosols

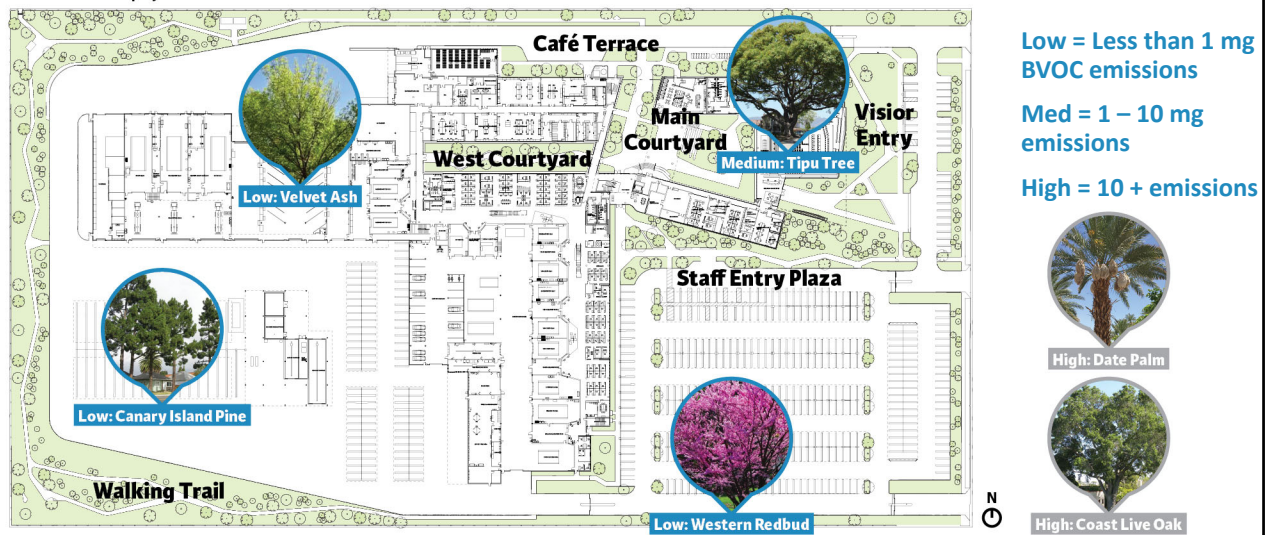


19

BALANCING PROGRAM AND ZERO CARBON

Biogenic Emissions: Low BVOC Plants = Better Ozone !

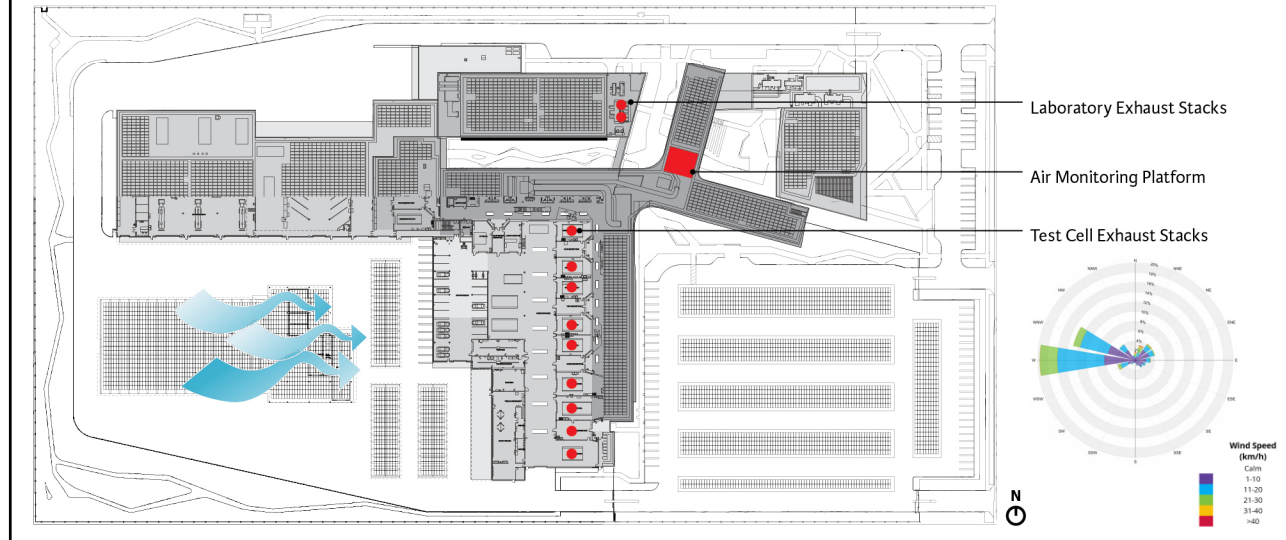
www.selecttree.calpoly.edu



20

BALANCING PROGRAM AND ZERO CARBON

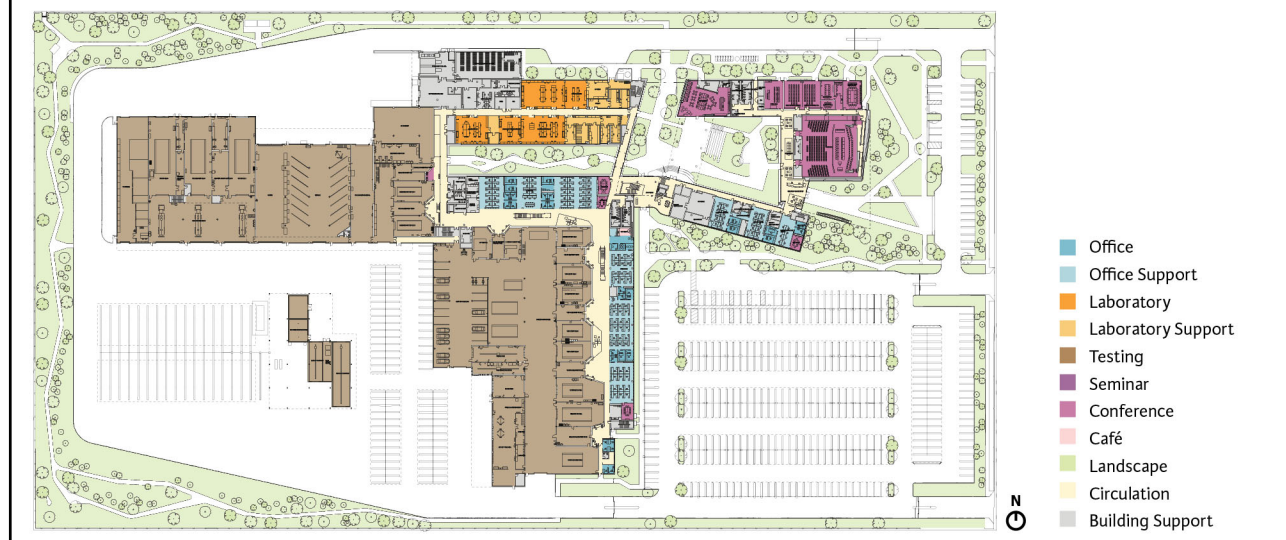
Roof Plan



21

BALANCING PROGRAM AND ZERO CARBON

Level 1: Testing, Office, Chemistry Laboratories, Education / Conference



22

BALANCING PROGRAM AND ZERO CARBON

Light Duty Testing and Atrium Adjacency



23

BALANCING PROGRAM AND ZERO CARBON

Chemistry Laboratory: Intense MEP requirements

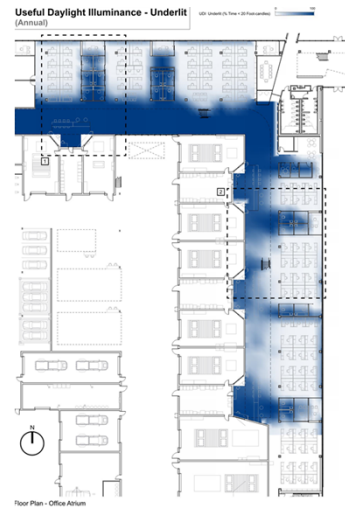


24

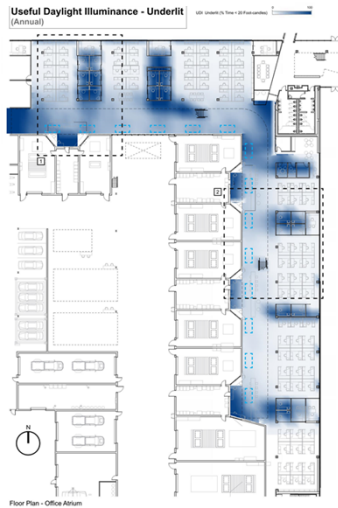
BALANCING PROGRAM AND ZERO CARBON

Passive Systems: Daylighting

DAYLIGHTING WITHOUT SKYLIGHTS



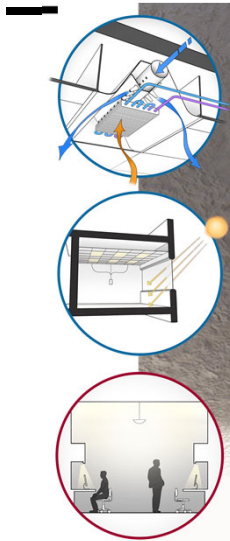
DAYLIGHTING WITH SKYLIGHTS



25

BALANCING PROGRAM AND ZERO CARBON

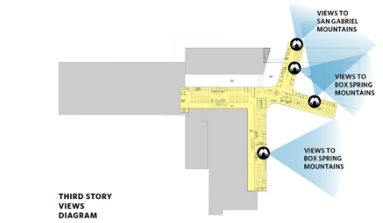
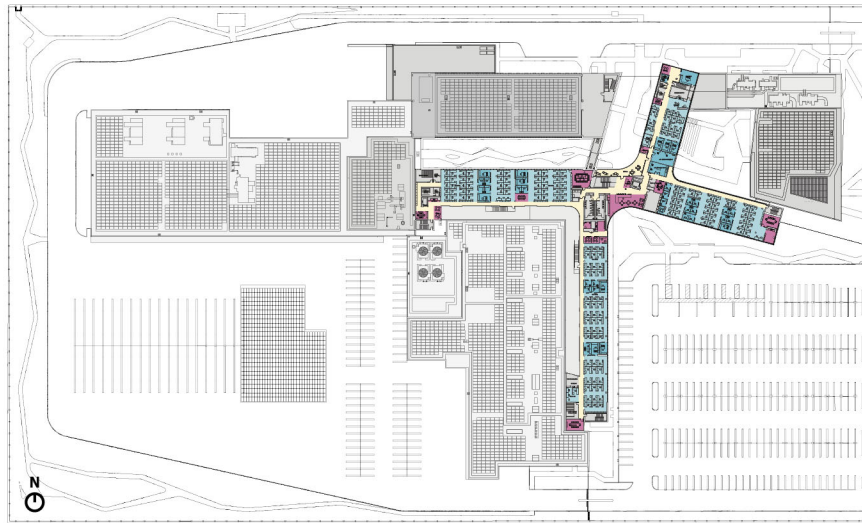
Level 2: Open Office and Atrium



26

BALANCING PROGRAM AND ZERO CARBON

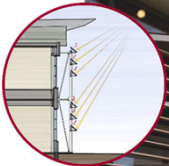
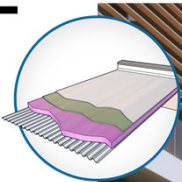
Level 3: Office and Roof



27

BALANCING PROGRAM AND ZERO CARBON

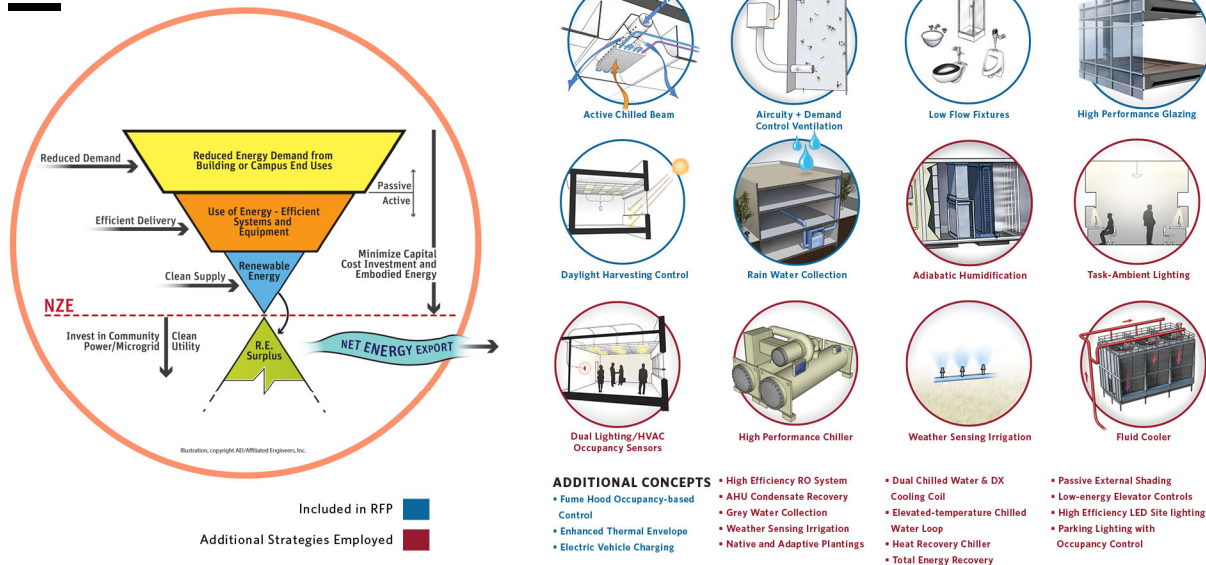
High Performance Building Envelope: Office



28

INTEGRATED DESIGN STRATEGIES

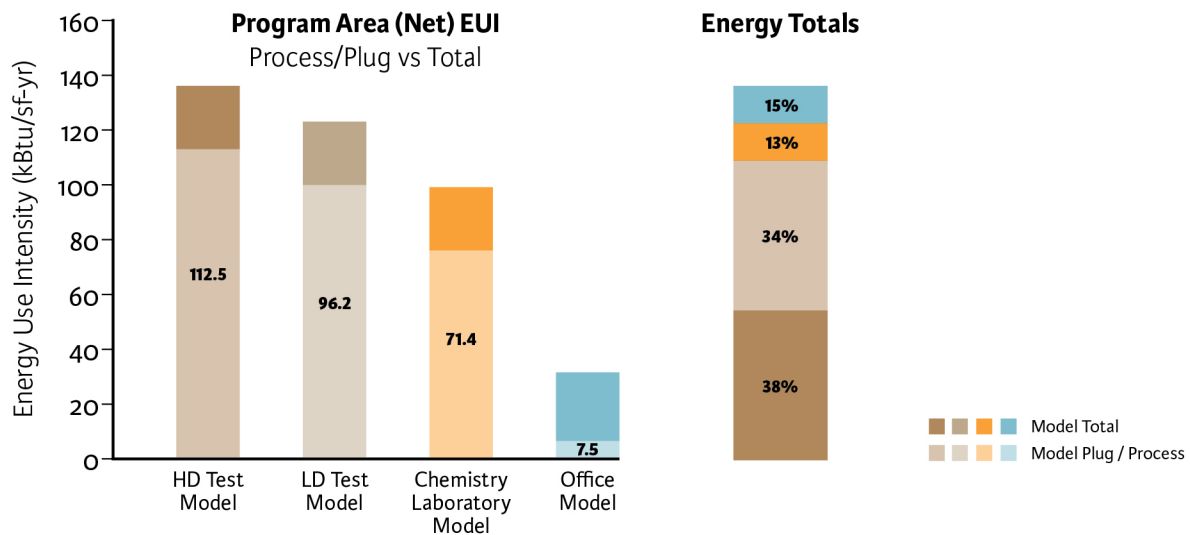
RFP Requirements: NZE and a Powerful Vehicle Testing Program



29

INTEGRATED DESIGN STRATEGIES

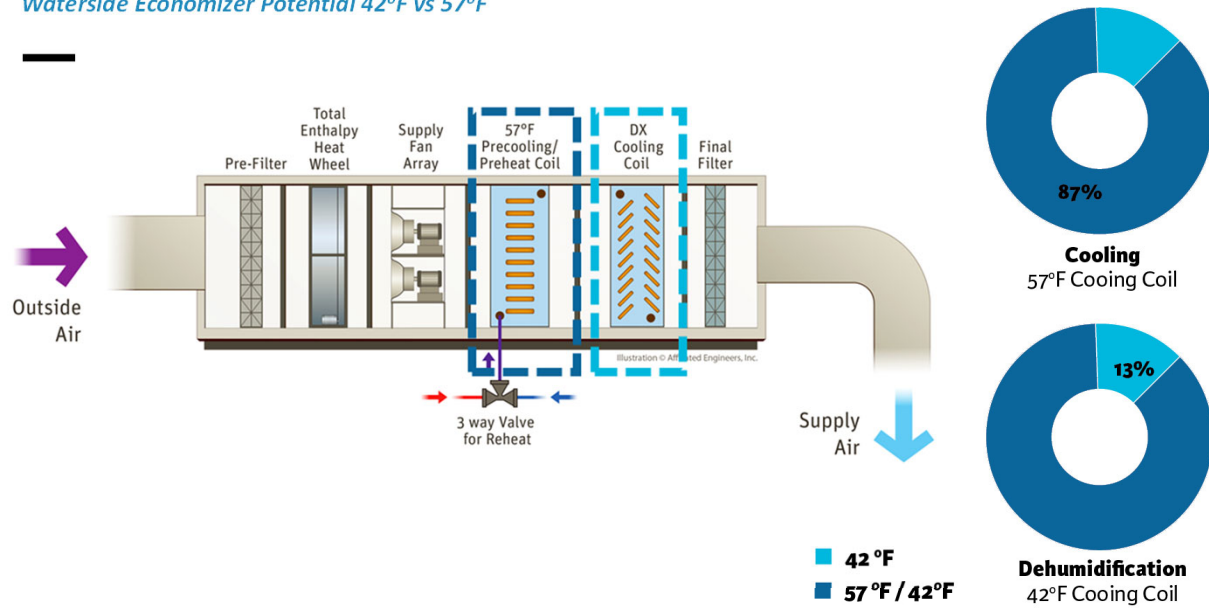
Program Area EUI: Plug and Process EUI vs Total by Program Area



30

INTEGRATED DESIGN STRATEGIES

Waterside Economizer Potential 42°F vs 57°F



31

INTEGRATED DESIGN STRATEGIES

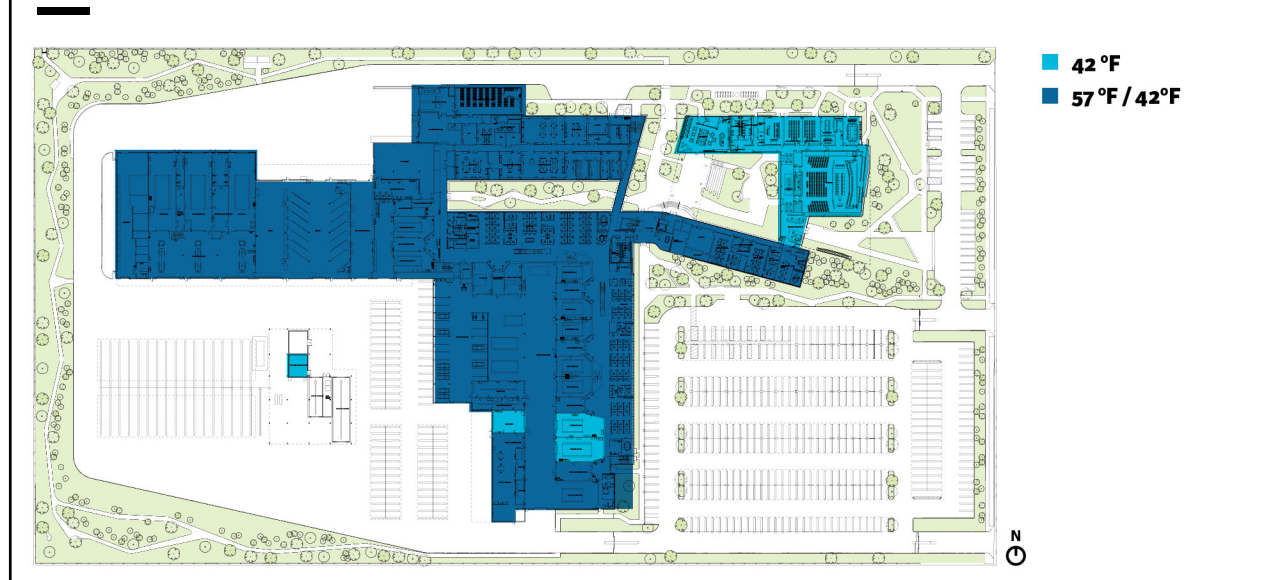
Chilled Water Distribution: RFP System Design



32

INTEGRATED DESIGN STRATEGIES

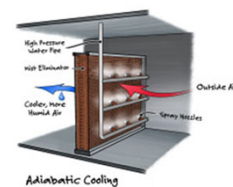
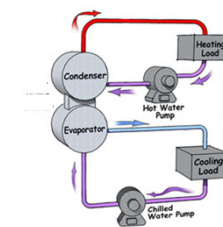
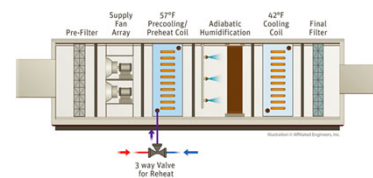
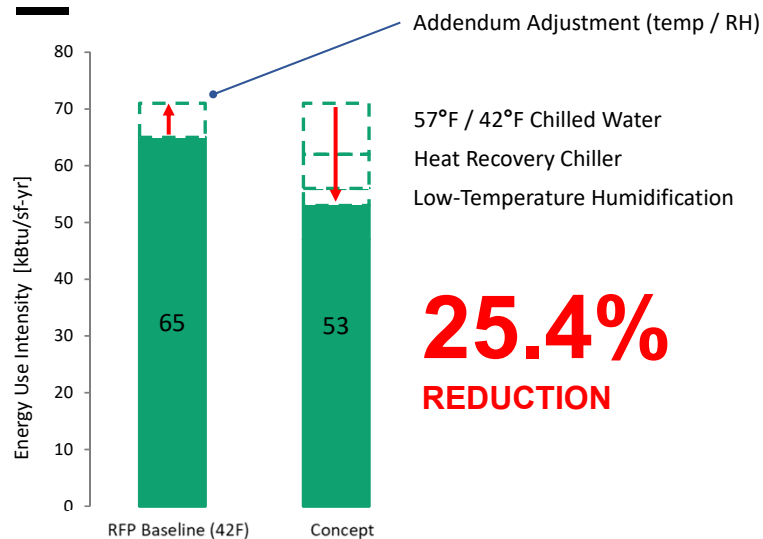
Chilled Water Distribution: Climate and Program-Informed System Design



33

INTEGRATED DESIGN STRATEGIES

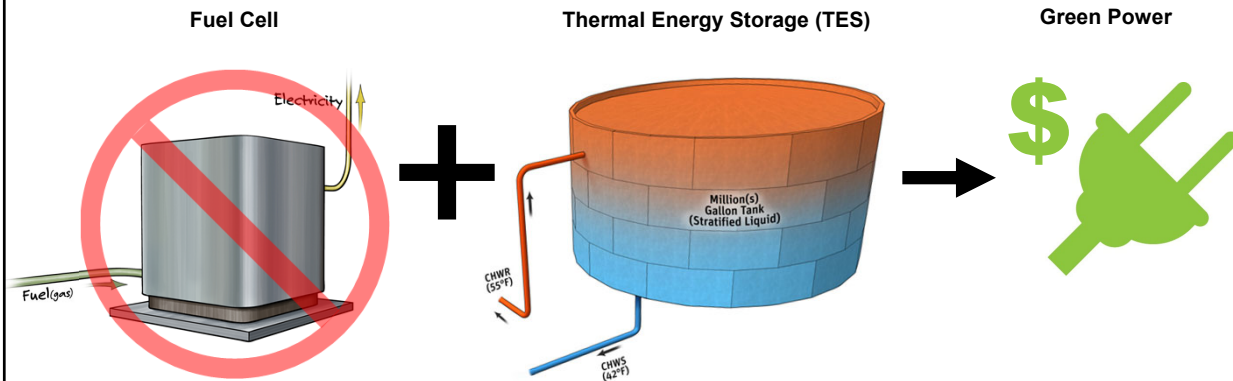
EUI Comparison



34

ENERGY GENERATION AND STORAGE

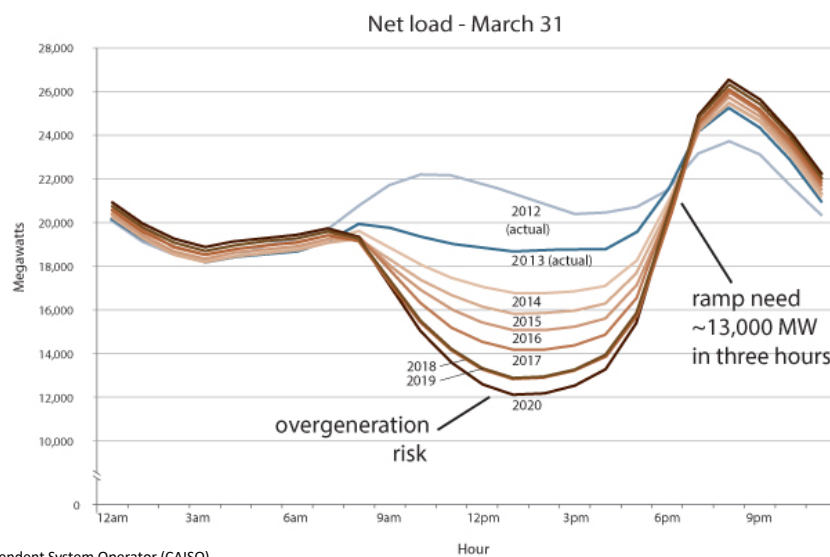
RFP Concept Validation of Fuel Cell + Absorption Chiller + TES Tank



35

ENERGY GENERATION AND STORAGE

Future of Energy Rates and Demand Charges

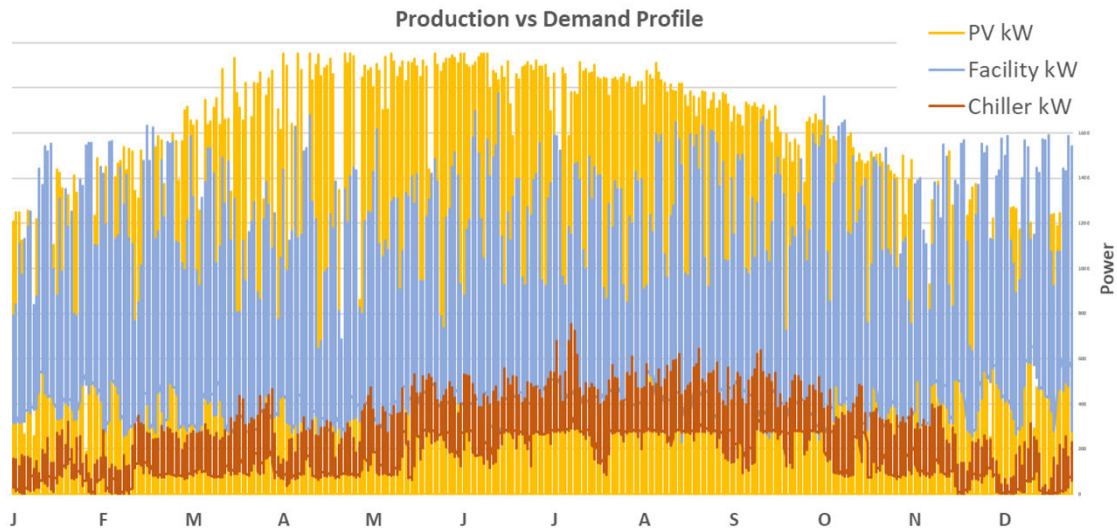


Source: California Independent System Operator (CAISO)

36

ENERGY GENERATION AND STORAGE

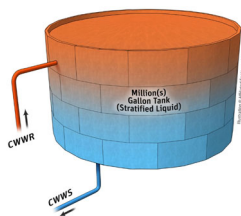
Grid Harmonization: PV Production vs Use On-Site Without TES



37

ENERGY GENERATION AND STORAGE

RFP Concept Validation for Grid Harmonization



TES

- \$24,000 / year demand savings
- \$13,000 / year energy savings
- 40-year simple payback
- Provides some redundancy



Add 1.5 MWh Battery

- \$58,000 / year demand savings
- \$0 / year energy savings
- 26-year simple payback
- Flexible demand reduction



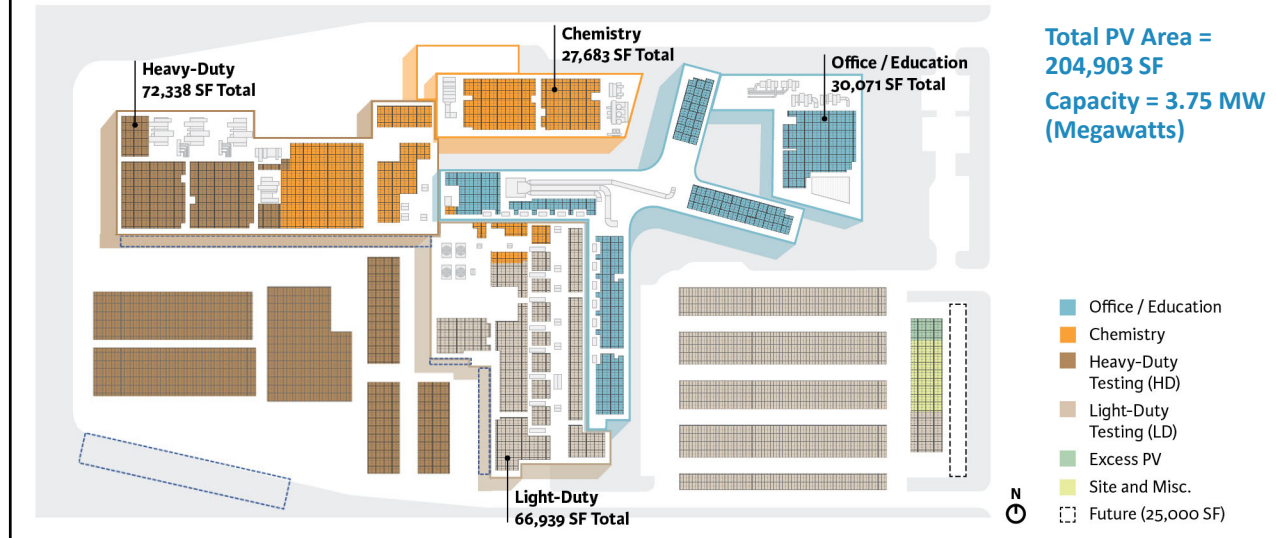
Add 300 kW PV

- \$14,800 / year demand savings
- \$58,300 / year energy savings
- **9-year simple payback**
- **On-site ZNE**

38

ENERGY GENERATION AND STORAGE

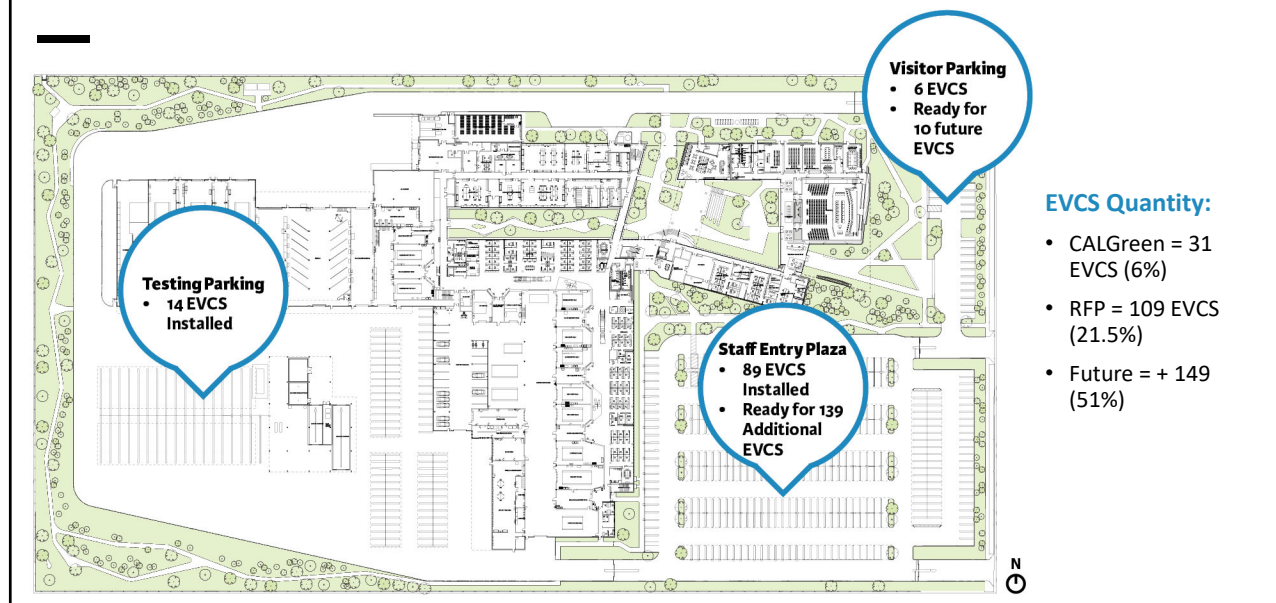
Photovoltaic (PV) System



39

ELECTRIC VEHICLE CHARGING

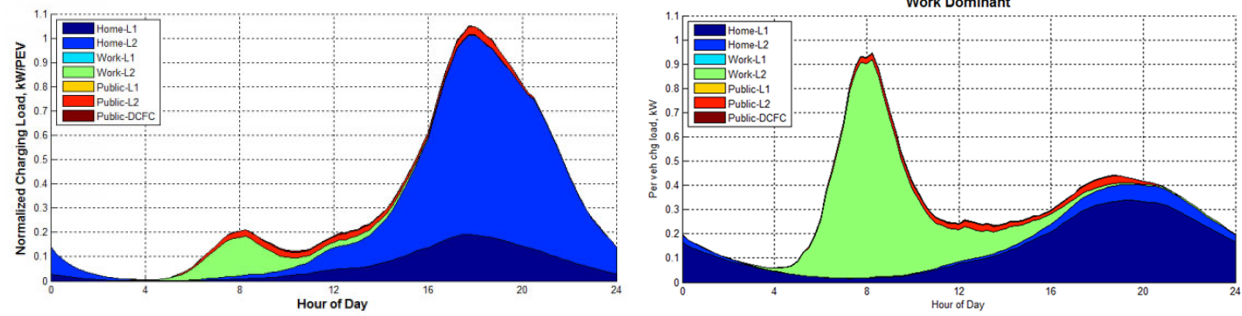
Electric Vehicle Charging Stations (EVCS)



40

ELECTRIC VEHICLE CHARGING

Considering EV Charging Loads for Design and Grid Harmonization

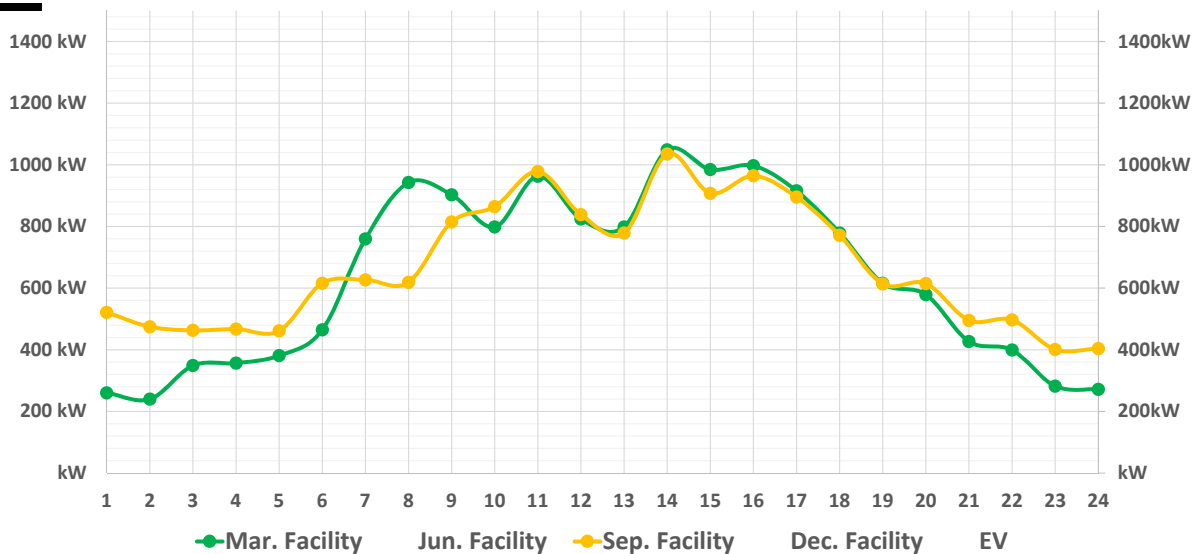


Source: NREL "National Plug-In Electric Vehicle Infrastructure Analysis"

41

ELECTRIC VEHICLE CHARGING

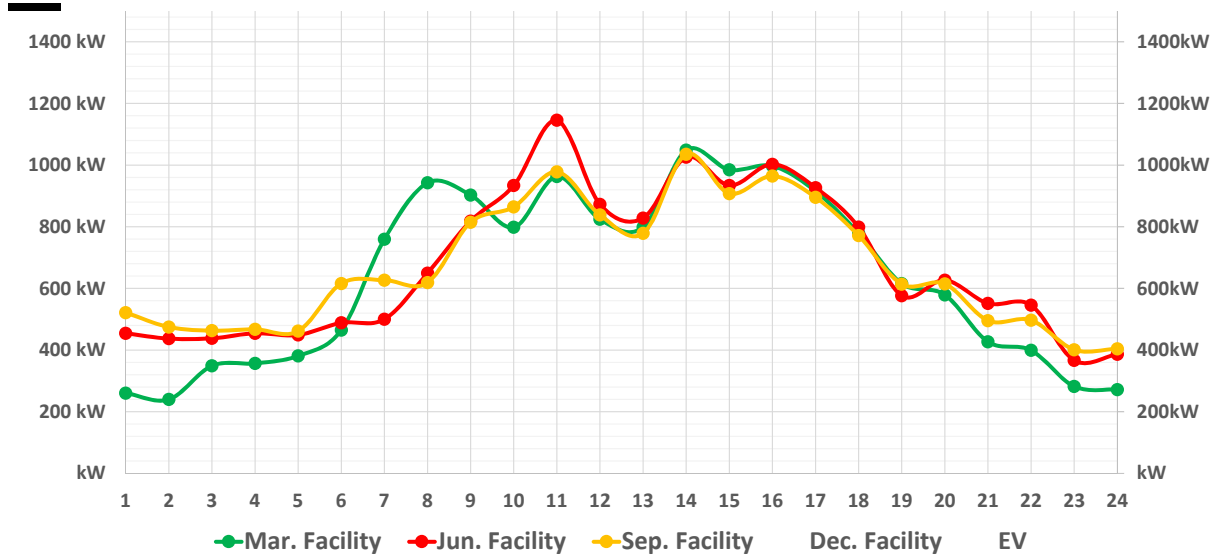
Considering EV Charging Loads for Design and Grid Harmonization



42

ELECTRIC VEHICLE CHARGING

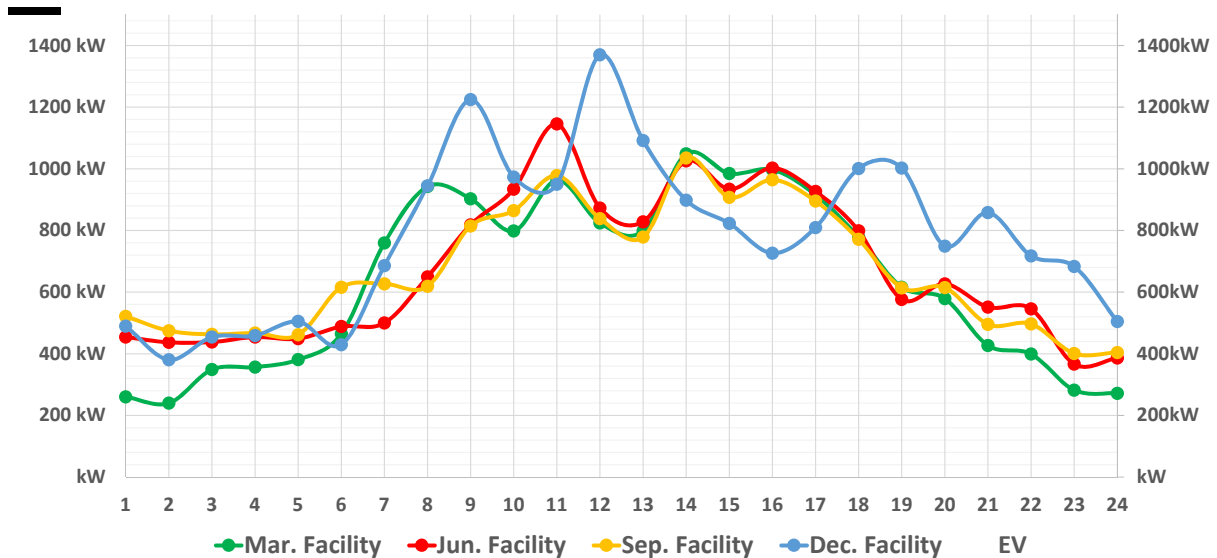
Considering EV Charging Loads for Design and Grid Harmonization



43

ELECTRIC VEHICLE CHARGING

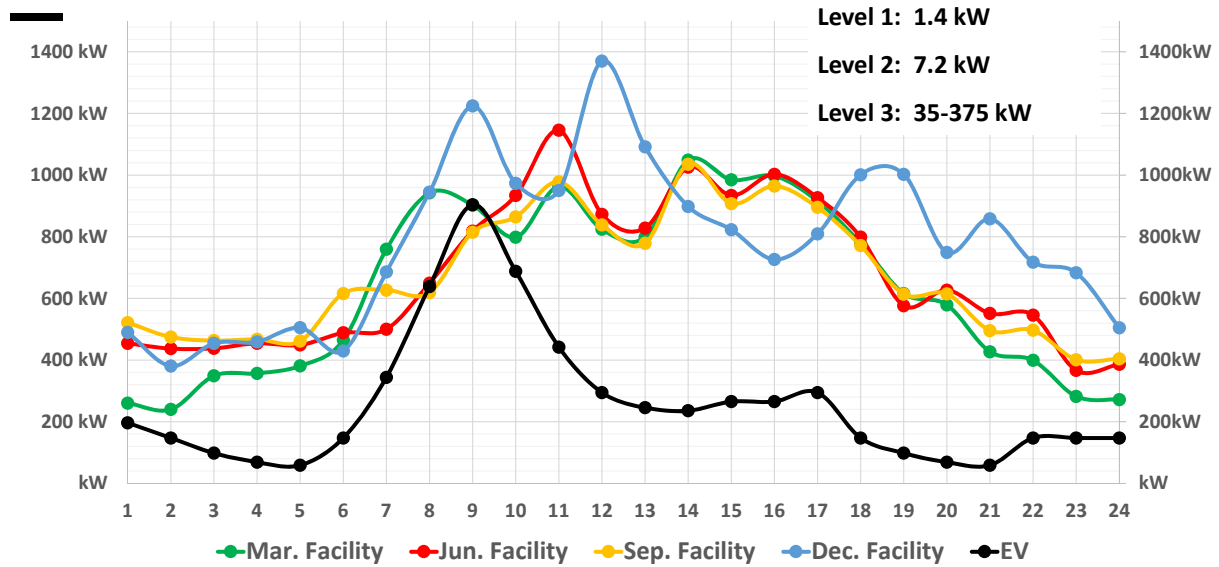
Considering EV Charging Loads for Design and Grid Harmonization



44

ELECTRIC VEHICLE CHARGING

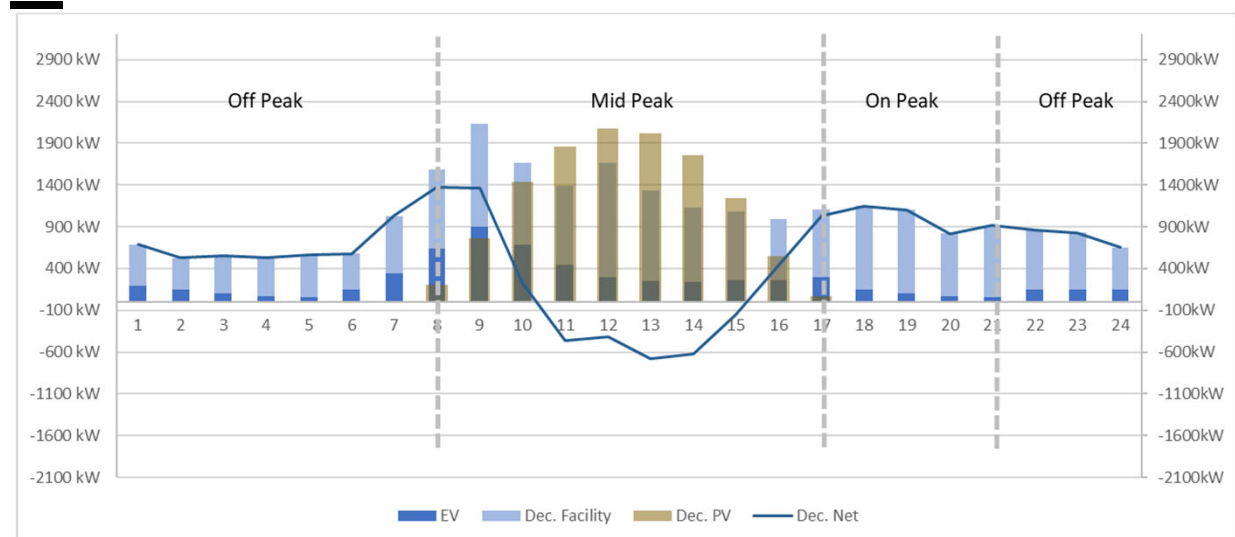
Considering EV Charging Loads for Design and Grid Harmonization



45

ELECTRIC VEHICLE CHARGING

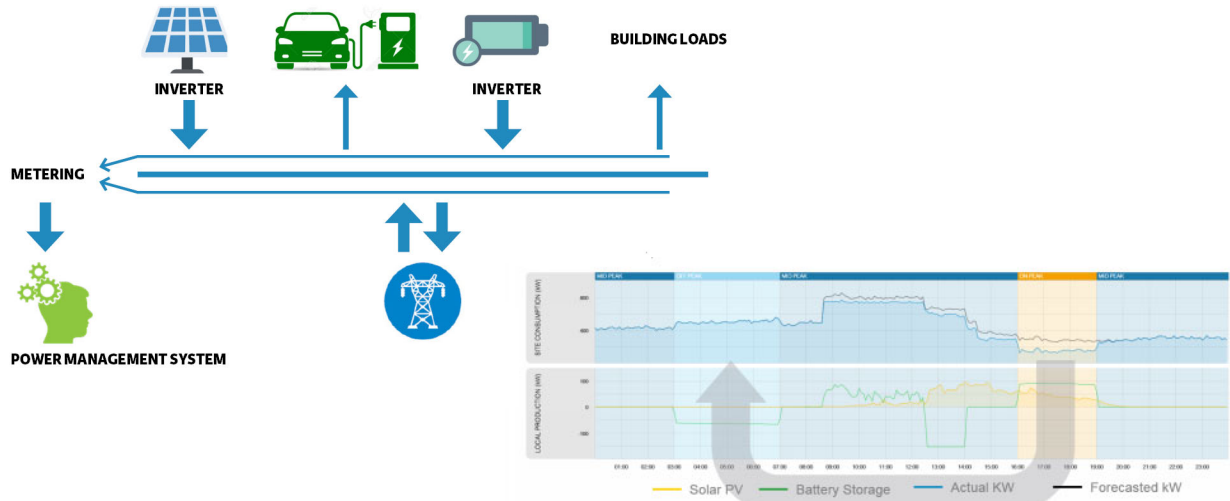
Building + EV Demand vs. PV – Average December Temperatures



46

ENERGY MANAGEMENT

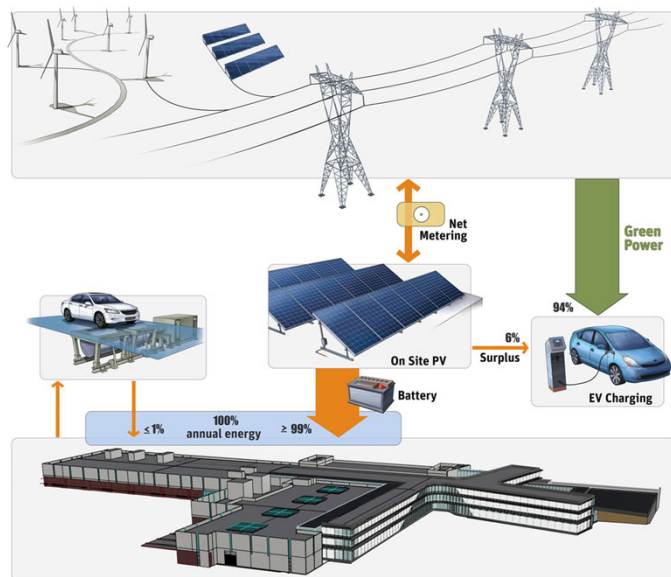
Metering, Monitoring, Demand and Utility Costs



47

CALIFORNIA AIR RESOURCES BOARD

New Headquarters in Riverside



ZERO

Energy On-Site

ZERO

Net-Carbon

75%

Energy Cost Savings

<10YR

Payback Period

48



ZERO
Energy On-Site

ZERO
Net-Carbon

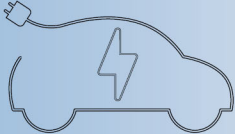
75%
Energy Cost Savings

<10YR
Simple Payback

49

**California Department
of General Services**

Southern California
Consolidation Project
Riverside, California


AIR 

RESOURCES


BOARD

Getting to Zero National Forum
Scaling Up; Insights from the New CARB Zero Energy
Emissions Testing and Research Facility | October 11, 2019

A DESIGN-BUILD PARTNERSHIP

 **HENSEL PHELPS**
Plan. Build. Manage.

ZGF

 **AEI** Affiliated
Engineers

50