I²SL Annual Conference

Driving to a Sustainable Laboratory – The Cross Pollination of Innovation and Policy

Marisa Keckeisen, ZGF; Paul Erickson, AEI

October 21, 2019
LEARNING OBJECTIVES

01 **Objective One**
Develop an understanding of key space planning elements that effect large scale project with complicated programs and multi-tiered divisions within the organization;

02 **Objective Two**
Explain how the interior environment can contribute to behavior changes and communal interaction;

03 **Objective Three**
Recognize and understand the application of passive and active design strategies in context of local climate, mix of program types;

04 **Objective Four**
Identify the factors that need to be considered for on-site NZE for a large and complex facility, including aesthetic, utility mix, utility rates, and grid harmonization.
INTRODUCTION

CARB’s Mission
INTRODUCTION

CARB’s Impact
INTRODUCTION

CARB’s Mission
INTRODUCTION

CARB’s Impact

1956
1967 Federal Air Quality Act and creation of CARB

1967

1970s
Catalytic Converter (Smog Reduction)

1990s
Check Engine Light

2010s
VW Defeat Device

2019

[Image of smoggy cityscape]
INTRODUCTION

CARB’s New Headquarters
INTRODUCTION

CARB’s New Headquarters

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

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
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
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%
THE BASICS
RFP Benchmarks: Metering and Scaling Up

RFP - TEST

- Dynamometers: 8%
- LD Test Gross: 5%
- LD Test MEP: 11%
- HD Test MEP: 11%
- HD Test Equipment: 30%
- LD Test Equipment: 32%

Actual Electrical Usage HSL
THE BASICS
Building Program and Energy Usage

Proportion of Program Area and Energy Use

<table>
<thead>
<tr>
<th>Area</th>
<th>Office</th>
<th>Chemistry</th>
<th>Heavy-Duty Testing (HD)</th>
<th>Light-Duty Testing (LD)</th>
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</thead>
<tbody>
<tr>
<td>Proportion</td>
<td>41%</td>
<td>9%</td>
<td>30%</td>
<td>20%</td>
</tr>
<tr>
<td>Total</td>
<td>402,000 SF</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy</th>
<th>Office</th>
<th>Chemistry</th>
<th>Heavy-Duty Testing (HD)</th>
<th>Light-Duty Testing (LD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion</td>
<td>15%</td>
<td>34%</td>
<td>38%</td>
<td>13%</td>
</tr>
<tr>
<td>Total</td>
<td>55 KBTU/SF-YR</td>
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</tbody>
</table>
THE BASICS

Electrical Systems Supporting the ZNE Solution
THE BASICS

ZNE Analysis Tools and Design Concept
THE BASICS

Concept Aerial View
BALANCING PROGRAM AND ZERO CARBON

Exhaust Management
TEST CELL TO LAB SAMPLE

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

Building Program – Vehicle and Engine Test Cells
TEST CELL TO LAB SAMPLE

Level 1: Testing, Office, Chemistry Laboratories, Education / Conference
TEST CELL TO LAB SAMPLE

*Light Duty Testing and Atrium Adjacency*
TEST CELL TO LAB SAMPLE

Path of Travel
TEST CELL TO LAB SAMPLE

Chemistry Laboratory: Intense MEP Requirements
TEST CELL TO LAB SAMPLE

Chemistry Laboratory: Intense MEP Requirements
TEST CELL TO LAB SAMPLE

Chemistry Laboratory: Intense MEP Requirements
TEST CELL TO LAB SAMPLE

Path of Travel
TEST CELL TO LAB SAMPLE: SUPPORT

Open Office and Atrium
INTEGRATED DESIGN STRATEGIES

RFP Requirements: NZE and a Powerful Vehicle Testing Program

ADDITIONAL CONCEPTS
- Fame Hood Occupancy-based Control
- Enhanced Thermal Envelope
- Electric Vehicle Charging
- High Efficiency RO System
- AHU Condensate Recovery
- Grey Water Collection
- Weather Sensing Irrigation
- Native and Adaptive Plantings
- Dual Chilled Water & DX Cooling Coil
- Elevated-temperature Chilled Water Loop
- Heat Recovery Chiller
- Total Energy Recovery
- Passive External Shading
- Low-energy Elevator Controls
- High Efficiency LED Site Lighting
- Parking Lighting with Occupancy Control

KEY
- Included in RFP
- Additional Strategies Employed
INTEGRATED DESIGN STRATEGIES

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

Program Area (Net) EUI
Process/Plug vs Total

Energy Totals

<table>
<thead>
<tr>
<th>Program Area</th>
<th>Process/Plug</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD Test Model</td>
<td>112.5</td>
<td></td>
</tr>
<tr>
<td>LD Test Model</td>
<td>96.2</td>
<td></td>
</tr>
<tr>
<td>Chemistry Laboratory Model</td>
<td>71.4</td>
<td></td>
</tr>
<tr>
<td>Office Model</td>
<td>7.5</td>
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</tbody>
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Energy Totals:
- Model Total: 15%
- Model Plug/Process: 34%
- Total: 38%
INTEGRATED DESIGN STRATEGIES
Leveraging The Local Climate
INTEGRATED DESIGN STRATEGIES
Chilled Water Distribution: RFP System Design
INTEGRATED DESIGN STRATEGIES

Chilled Water Distribution: Climate and Program-Informed System Design
INTEGRATED DESIGN STRATEGIES

EUI Comparison

Addendum Adjustment (temp / RH)

57°F / 42°F Chilled Water
Heat Recovery Chiller
Low-Temperature Humidification

25.4% REDUCTION
ENERGY GENERATION AND STORAGE

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

Fuel Cell + Thermal Energy Storage (TES) → Green Power
ENERGY GENERATION AND STORAGE
Future of Energy Rates and Demand Charges

Source: California Independent System Operator (CAISO)
ENERGY GENERATION AND STORAGE

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

Production vs Demand Profile

- PV kW
- Facility kW
- Chiller kW

Power

J F M A M J J A S O N D
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
ENERGY GENERATION AND STORAGE

Photovoltaic (PV) System

Total PV Area = 204,903 SF
Capacity = 3.75 MW (Megawatts)
ENERGY MANAGEMENT

Metering, Monitoring, Demand, and Utility Costs
CALIFORNIA AIR RESOURCES BOARD

New Headquarters in Riverside

ZERO Energy On-Site

ZERO Net-Carbon

75% Energy Cost Savings

<10YR Payback Period
ZERO Energy On-Site

ZERO Net-Carbon

75% Energy Cost Savings

<10YR Simple Payback
QUESTIONS?

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