SOUTHERN CALIFORNIA REGIONAL LAB CONSIDERATIONS

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LEARNING OBJECTIVES

Learning Objective 1: Attendees will learn about the current and future climatic challenges facing Southern California and its built environment;

Learning Objective 2: Attendees will learn about siting & architectural strategies for achieving a sustainable research facility in Southern California;

Learning Objective 3: Attendees will also learn about energy conservation strategies for achieving a sustainable research facility in Southern California; and

Learning Objective 4: Finally, attendees will also learn about water conservation strategies for achieving a sustainable research facility in Southern California.
AGENDA

1. SOUTHERN CALIFORNIA CRITICAL CONDITIONS

2. CA T24 ENERGY AND GREEN BUILDING CODE

3. TWO CASE STUDIES

4. LESSONS LEARNED
SOCAL RISING TEMPERATURE

- Temperature is rising on an average of 1F every 10 years
- Estimate around 3-5 F rise in temperature for year 2050

Source: Dan Cayan et al. 2009
SOCAL DROUGHT

- CA is receiving less rainfall from past 10 years
- Southern CA was in exceptional drought until last year

Source: U.S. Drought Monitor
CA POPULATION

• Resources are diminishing & population is increasing
• CA is expected to grow 10% every ten years

Source: California Department of finance projections, 2013 series
CA T24 ENERGY CODE & CALGREEN CODE

LA COUNTY GOALS – NET ZERO CARBON GOALS
2025: New buildings & 50% of building renovations
2035: 75% of major building renovations
2045: 100% of major building renovations

University Of California = 20% Energy Reduction Over T24 Code
California State Universities = 10% Beyond Above T24 Code & 12% Beyond T24 For Water
UC Universities: No Natural Gas

CONTROLS & MAINTENANCE
REDUCE LOAD & EFFICIENT SYSTEMS
CA ENERGY & GREEN BUILDING CODE
COUNTY MANDATES
CALIFORNIA UNIVERSITY MANDATES

CA/LEED SILVER
<table>
<thead>
<tr>
<th>Topic</th>
<th>Energy &amp; Green Building Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Performance Of Envelope</td>
<td>~R-19 Walls, R-30 ci Roof</td>
</tr>
<tr>
<td>Cool Roof</td>
<td>Aged SRI -0.63, Thermal Emittance -0.75</td>
</tr>
<tr>
<td>Lighting</td>
<td>0.7 W/SF for Offices, Daylight harvesting + Dimming/ Scheduled Control/ Vacancy/occupancy sensor mandatory</td>
</tr>
<tr>
<td>Commissioning</td>
<td>Basic -Mandatory</td>
</tr>
<tr>
<td>Outdoor Water Use</td>
<td>No Potable Water Usage/Requires Use of Reclaimed Water/Grey Water in many counties</td>
</tr>
<tr>
<td>Indoor Water Use</td>
<td>1.28 gpm Water Closet, 0.125 gpf Urinal, 0.5 gpm Lavatory Faucet, Water Faucet Metering</td>
</tr>
<tr>
<td>Submetering – Lighting, Plug Loads etc.</td>
<td>Mandatory</td>
</tr>
<tr>
<td>Outside Air Requirement</td>
<td>Max. of 15 cfm/person OR 0.15 cfm/SF</td>
</tr>
<tr>
<td>Minimum Efficiency for HVAC Equipment</td>
<td>Stringent- HVAC System, Chillers, boilers</td>
</tr>
<tr>
<td>Construction Waste Management</td>
<td>~65% is Mandatory</td>
</tr>
<tr>
<td>Low VOC for Adhesives, Paints</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>
CASE STUDY 1
UCR MULTIDISCIPLINARY RESEARCH BUILDING
RIVERSIDE, CA
RIVERSIDE, CA

- 118 F record high temperature
- High temperatures throughout summer
- Clear sky throughout the summer
- Outside air economizer opportunity for > 55% of year
- 57% of the sun hours >65 deg F
- Average monthly precipitation is 1.1 inches
UCR MULTIDISCIPLINARY RESEARCH BUILDING

OVERVIEW

- 182K GSF (5 Floors)
- Professional Research Facility
- LEED Platinum (2009)
- Spring 2019 Completion
UCR MULTIDISCIPLINARY RESEARCH BUILDING

OVERVIEW

- Open Labs + Lab Support
- Vivarium
- Central Atrium
- Collaboration
- Proper placement of spaces based on orientation
- Reduced WWR on West façade
- WWR - 32%
- Large overhangs + fins on eastern facade
- Shading device optimized to reduce peak summer sun
- Still allowing useful daylight to passively heat the space in winter
UCR MULTIDISCIPLINARY RESEARCH BUILDING

SHADING

Large overhangs on eastern facade

Well shaded and daylight interior and exterior space

Well daylight atrium
UCR MULTIDISCIPLINARY RESEARCH BUILDING

DAYLIGHTING + LIGHTING

- All LED Lighting
- Continuous Dimming + Shutoff
- Daylight Harvesting
- 54% Lighting Energy Savings above ASHRAE 90.1 2007 baseline
- High Reflective Surfaces

UDI 100-2000 lux

Shade device with 27” depth
UCR MULTIDISCIPLINARY RESEARCH BUILDING

OUTDOOR WATER USE

- Drought Tolerant Landscaping
- Drip Irrigation
- Recycled greywater & Condensate collection is used for Irrigation

![Chart showing outdoor water use]
UCR MULTIDISCIPLINARY RESEARCH BUILDING

- 1.28 gpm water closet, 0.125 gpf urinals & 0.5 gpm water faucet
- Recycled Grey water used for flushing toilets (~400k gallons)
- 85% water savings against ASHRAE 90.1 2007 baseline
Lab Process Water Reused (~400K gal.) to flush toilet fixtures
UCR MULTIDISCIPLINARY RESEARCH BUILDING

ENERGY EFFICIENCY

- Variable Volume Venturi Valve Air Handlers
- Demand Controlled ventilation
- Aircuity
- Sash control in Fume hoods
- Highly efficient sterilizers
- Heating and cooling from campus boilers & chillers

PREDICTED HVAC MODE
All annual hours: High internal load spaces

ASHRAE 90.1 2007 BASELINE

PROPOSED

- Heating
- Cooling
- Lighting
- Exhaust Lighting
- Equipment
- Fan
- Heat Rejection
- Pump
- DHW
- Savings

22% Cooling and Dehumidification
16% Cooling Only
55% Economizer
7% Heating

29% Heating
13% Cooling
18% Lighting
21% Exhaust Lighting
8% Equipment
0% Fan
2% Heat Rejection
17% Pump
21% DHW
2% Savings
UCR MULTIDISCIPLINARY RESEARCH BUILDING

ONSITE RENEWABLES

- UC net zero greenhouse emissions by 2025
- UCR Solar Farm
- 9,600 Solar Panels / 4.3 Megawatts
- Total energy cost savings = 34.1% above ASHRAE 90.1 2007
- Total energy cost savings with PV = 44% above ASHRAE 90.1 2007
- Achieving 17 points in LEED Energy & Atmosphere credit
UCR MULTIDISCIPLINARY RESEARCH BUILDING

CHALLENGES / LESSONS LEARNED

▪ Shared Sustainability Leadership

▪ Recurring Sustainability Meetings Through Project Closeout

▪ Early AHJ and Facilities Buy-in at Concept Stage

▪ Preserving Sustainability During VE
CASE STUDY 2
CALTECH CHEN NEUROSCIENCE LABORATORY

PASADENA, CA
- High temperature during later summer (Aug-Sep)
- 75% Clear sky throughout summer
- 56% of the sun hours >65 deg F
- Outside air economizer opportunity for > 55% of year
- Average monthly precipitation is 1.4 inches, ~ 0 inches in summer
- Temperature below 50 F < 10%
CALTECH CHEN NEUROSCIENCE LABORATORY

OVERVIEW

- 5 story, 180,000 SF Laboratory Space
- Neuroscience Research Facility
- LEED Gold anticipated
- Fall 2020 Completion
- EUI – 298 kBtu-hr/SF
Proper placement of spaces based on orientation
- WWR - 39%
- Reduced WWR on East facade
- Large overhangs on south and western facade
- Fins on west and east facade
Daylight Harvesting - 58% of the occupied area meets 300 LUX for 50% of the hours
39.5 % Lighting Energy Savings above ASHRAE 90.1 2010 baseline (0.6 W/SF)
High Reflective Surfaces
All Lighting Fixtures = 5000 K are higher
Integrated landscape
Drought Tolerant plants
Preserve existing plants
Plumbing Fixtures:
- 1.28 gpm water closet, 0.125 gpf urinals & 0.5 gpm water faucet
- Building provided with reclaimed water system – purple pipe for future use.

Cage & Rack Washer:
Estimated water savings -50 to 60%
- Washer will be provided with Smart Cool Down option
- Fresh cool air introduced to the chamber to cool the load and the effluent prior to discharge.
- System will monitor the re-circulated water and will dispense to drain at the set temperature requirement.
- Eliminates 1000’s of gallons of cold water used for effluent cooling.

Sterilizers:
Estimated water Savings- 75%
- EnviroVac System – requires only 1/2” water feed at min. 20 psig
- DOAS + Active Chilled Beams - Labs & Offices
- 100% OA VAV - Vivarium
- VAV w/Economizer - Auditorium
- Lab Demand Controlled Ventilation w/Aircuity
- Variable Volume Fume hoods
- Campus CHW & Steam
- Efficient lab equipment
Lab equipment consumes **5.7 giga-watt hour** annually in Caltech.

The average percentage of lab equipment to total building energy consumption was **8.4%** for a typical Caltech lab and highest is **23%**.

Freezers, furnaces are the highest consumers at Caltech labs.

### LAB EQUIPMENT AVERAGE ENERGY CONSUMPTION/WEEK (kWh)

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Avg Consumption/Wk (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appliances/Cleaning</td>
<td>29</td>
</tr>
<tr>
<td>Centrifuges</td>
<td>19</td>
</tr>
<tr>
<td>Computing</td>
<td>22</td>
</tr>
<tr>
<td>Freezers</td>
<td>209</td>
</tr>
<tr>
<td>Furnaces/Ovens</td>
<td>168</td>
</tr>
<tr>
<td>Hoods &amp; BSCs</td>
<td>47</td>
</tr>
<tr>
<td>Incubators/Shakers</td>
<td>155</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>39</td>
</tr>
<tr>
<td>Vacuum Pumps</td>
<td>94</td>
</tr>
<tr>
<td>Other</td>
<td>25</td>
</tr>
</tbody>
</table>

Table Source: Caltech Energy Assessment for Laboratories (CEAL) Summer 2011 Progress Report
**STIRLING ENGINE ULT BENEFITS**

- 50-60% Energy Savings
- Helps downsize mechanical/electrical systems
- Space efficient
- Quiet
- Wide range temperature (−20°C to −95°C)
- Less refrigerant, Ethane refrigerant
- Less standby power

**VARIABLE SPEED COMPRESSOR BENEFITS**

- 50 Energy Savings
- Natural refrigerant
- Quiet system operation

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**EXISTING VS PROPOSED FREEZER**

Source: Caltech Sustainability review, AEI
Considering dry heat/moist heat for glassware, most metal instruments
- Dry-Heat Sterilization Only for oils powders & corrosive metals
- Heat/Energy Reclaim can save 50-60% of water in rack washers & 80-90% in autoclaves

**AUTOCLAVES**

<table>
<thead>
<tr>
<th>Model</th>
<th>Initial Cost</th>
<th>Operating Cost</th>
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</thead>
<tbody>
<tr>
<td>AMSCO® CENTURY® STEAM</td>
<td>$96,100</td>
<td>$18K</td>
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<tr>
<td>STEAM STERILIZER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHW</td>
<td>$99,200</td>
<td>$17K</td>
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<tr>
<td>AMSCO® CENTURY® STEAM</td>
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<td></td>
</tr>
<tr>
<td>STEAM STERILIZER +Heat</td>
<td>$73,100</td>
<td>$6K</td>
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<tr>
<td>Reclaim</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMSCO® CENTURY® STEAM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEAM STERILIZER +Heat</td>
<td>$72,800</td>
<td>$6K</td>
</tr>
<tr>
<td>Reclaim + HR &amp; CHW</td>
<td></td>
<td>$6K</td>
</tr>
<tr>
<td>Priorclave 320L</td>
<td>$72,800</td>
<td>$6K</td>
</tr>
<tr>
<td>Dry Heat Autoclave</td>
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<td>$6K</td>
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**RACK WASHERS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Initial Cost</th>
<th>Operating Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better Built R630 Basic</td>
<td>$15,200</td>
<td>$4.6K</td>
</tr>
<tr>
<td>CHW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Better Built R630 +CHW</td>
<td>$14,100</td>
<td>$4.6K</td>
</tr>
<tr>
<td>CWF + FT + RT</td>
<td></td>
<td>$11,000</td>
</tr>
</tbody>
</table>

Source: Caltech Sustainability review, AEI
Campus energy intensity reduced from 380 kBtu/GSF to 300 kBtu/GSF (22% reduction)

Source: Caltech campus report
BENCHMARKING CRITERIA
- Limited to Climate Zone 3B
- Biology, Chemistry, Combination, Vivarium
- Lab Area 40-60%
- Total Floor Area < 200,000 SF
- All Mechanical System Types
- All Fume Hood Types

BENCHMARKING RESULTS
- Median Lab Area of 48%
- Median Site EUI (Energy Use Intensity) of 328 kBTU/sf/year
- 18 Buildings in Sample
Recurring Sustainability Meetings through project closeout

Emphasize on load reduction
  - Massing & Orientation
  - Thermal performance of Envelope Components

Educate client on industry standards

Start with Life Cycle Cost Analysis (LCCA) early in Design

VE Process – Provide Alternatives
QUESTIONS/DISCUSSION