Architecture 2030 for Labs

OHSU Knight Cancer Research Building

August 15, 2018
Presented to BESF
Outline

Overview
- Project Summary
- Energy Use in Labs
- Benchmarking and Energy Targets

Our Building
- Energy Trust Baseline
- Energy Conservation Measures
- Final Results
PROJECT GOAL

*Ending cancer as we know it.*

The Knight Cancer Research Building will be a key element in recruiting approximately 250 of the world’s leading cancer researchers and physicians as they lead the charge in curing cancer.
Phil Knight pledged $500M if $500M in private donations could be raised. The institute was seeded with $1B to create the building and populate it. Construction budget for the building was $160M.

TEAM:

SRG
PAE
OHSU
McCarthy
Andersen Construction

PROJECT SPECS
Pursuing LEED Platinum
333,000 square feet
IPD Contract with Co-Location and Triparty agreement
Project Overview
Project Overview

Rendering Courtesy of SRG
Project Overview

Rendering Courtesy of SRG
Project Overview
Energy Use in Lab Buildings

ESTIMATED ENERGY USE: 90.1-2010 ETO DATA

EUI (kBTU/sf/yr)

- LIGHTS
- PLUG LOADS
- SPACE HEATING
- SPACE COOLING
- VENT FANS
- OTHER MISC
- DOMEST HOT WTR

Religious Service
Warehouse & Storage
Office
Multifamily
Education
Service
Retail (other than Mall)
Public Assembly
Mercantile
Public Safety
Lodging
Health Care Outpatient
Health Care Inpatient
Health Care
Food Sales
Food Service
Labs
I²SL Database Peer Facilities

<table>
<thead>
<tr>
<th>I²SL Peer Facilities</th>
<th>EIU (Kbtu/sf/yr)</th>
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<tbody>
<tr>
<td>1</td>
<td>$2,500,000</td>
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<tr>
<td>2</td>
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<td>3</td>
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<tr>
<td>4</td>
<td>$2,000,000</td>
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<tr>
<td>5</td>
<td>$1,700,000</td>
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<tr>
<td>6</td>
<td>$1,300,000</td>
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<tr>
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<tr>
<td>8</td>
<td>$1,200,000</td>
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<tr>
<td>OHSU KCRB Target</td>
<td>$1,000,000</td>
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Energy Use in Lab Buildings - Baseline

- LIGHTS
- PLUG LOADS
- SPACE HEATING
- SPACE COOLING
- VENT FANS
- OTHER MISC
- DOMESTIC HOT WATER

LABS
~170 kBTU/SF/YR
Energy Use in Lab Buildings - Baseline

High Internal Loads
- Up to 10 W/sf
- Increases cooling energy, fan energy, heat rejection

Exhaust Rates
- 4-6 air changes per hour
- Increases fan energy, heating, cooling, and heat rejection
- Increases reheat

High Lighting Energy
- Lighting, cooling, fans

Long Operating Hours
- All of the above
Choose appropriate baseline

- Savings target for 2015-2019 = 70%
- Renewable energy (including purchase) can be 20% of the 70%
BENCHMARKING & ENERGY TARGETS

Marquam Hill Campus: 325 EUI
Similar Usage Labs (I^2SL): 265 EUI
Team Architecture 2030 Target: 100 EUI
Energy Use in Lab Buildings – Energy Savings Strategies

Lower Internal Loads
- Lights & equipment

Reduce Outside Air
- Lower air change rates
- Reuse outside air
- Variable supply & exhaust
- Limit envelope loads to OA requirements

Heat Recovery
- Air-to-air
- Water-to-water

Zone Cooling to Reduce/Eliminate Reheat
- Low static air distribution
- Select efficient equipment
Oregon Code Baseline

- Envelope just meeting OEESC
- Code maximum lighting power densities
- VAV air handlers two per floor (one for offices, one for labs)
- Water-cooled chiller plant
- 80% efficient gas-fired boilers
Traditional VAV

Exhaust Air Valve
Supply Air Valve
Supply Diffuser
Fume Hood
Exhaust Grille

VAV Terminal Unit
Supply Diffuser
Return Grille

Lab
Office
Mechanical Control Plant: Traditional Chiller & Boiler Plant
Energy Conservation Measures (ECMs)

- Efficient Air-side HVAC System
- Efficient Central Plant
- LED Lighting with Occupancy Sensors and Daylight Control
- Condensing Water Heaters with Low-flow Fixtures
- Wind-based Laboratory Exhaust Control Strategy
Building Envelope

- Maximize daylighting opportunity
- Making sure systems work with loads
- Loads more driven by internal gains and ventilation than envelope
Air-side HVAC

- More effective zoning (offices, labs, support areas, auditorium)
- Heat recovery via glycol run-around loop
- Transfer fans move air from offices to labs to provide required air changes
  - Minimum flow schedules on lab zones with transfer fans account for OA requirements only
  - Other air supplied room-neutral via transfer, so space temperature impacts not a concern
  - Transfer fan energy accounted for with direct metered load
  - Zone-by-zone hourly reports examined to verify desired airflows met
Transfer Fans
Heat Recovery
Air-side Improvements

After air-side improvements 131 EUI
Heat recovery chiller as primary cooling and heating source

Two other water-cooled chillers with cooling towers

Condensing gas boilers for remainder of heating needs

Free cooling capability through cooling towers when outdoor conditions allow

Variable speed pumping everywhere
Mechanical Central Plant: Heat Recovery Chiller
Water-side Improvements

After water-side improvements

EUI 129

Diagram showing energy use intensity (EUI) for different categories before and after improvements.
Lighting Upgrades

- All LED fixtures
- Occupancy sensors (credit taken where not code-required)
- Daylight harvesting with continuous dimming in south-facing labs and north-facing offices
Lighting Upgrades

After lighting upgrades 125 EUI
Service Hot Water Improvements

- Condensing gas-fired heaters for both domestic (lavatory) and process (laboratory) usage
- Low-flow fixtures in lavatories
Service Hot Water

123 EUI

After hot water improvements

1100
1250
1400
1550

kBtu/ft²/year

Code Baseline
Airside Improvements
Waterside Improvements
Lighting Improvements
Service HW Improvements
Architecture 2030 Target

EXT USAGE
DOMEST HOT WTR
VENT FANS
PUMPS & AUX
HEAT REJECT
SPACE COOLING
SPACE HEATING
PLUG LOADS
LIGHTS
Control of Laboratory Exhaust

- Use VFDs with redundant fans to reduce fan energy
- Select number and speed of fans to meet necessary plume
- Wind study/mock-up performed to inform control sequence
- On-site weather station provides wind conditions
Control of Laboratory Exhaust

<table>
<thead>
<tr>
<th>Fan System:</th>
<th>LEF-3,4,5,6</th>
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<tr>
<td>Design Criterion:</td>
<td>400</td>
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<tr>
<td>Stack Height:</td>
<td>30ft</td>
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<tr>
<td>Volume Flow Rate:</td>
<td>37,000 cfm</td>
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<tr>
<td>Exit Velocity:</td>
<td>2,775 fpm</td>
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<tr>
<td>Anemometer Height:</td>
<td>12ft above the CLSB Penthouse</td>
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### Minimum Fan Speed

| Wind Direction | Min | Max | 1 | 2 | 3 | 4 | 5 | 6 | 8 | 10 | 12 | 14 | 16 | 19 | 22 | 25 |
|----------------|-----|-----|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|
|                | 350 | 10  | 48%| 50%| 58%| 61%| 68%| 78%| 78%| 94%| 94%| 90%| 100| 100| 100| 100| 100|
|                | 10  | 30  | 48%| 50%| 55%| 60%| 68%| 75%| 95%| 95%| 100| 100| 100| 100| 100| 100| 100|
|                | 30  | 50  | 48%| 47%| 52%| 58%| 63%| 74%| 85%| 85%| 100| 100| 100| 100| 100| 100| 100|
|                | 50  | 70  | 48%| 17%| 31%| 43%| 54%| 73%| 90%| 100| 100| 100| 100| 100| 100| 100| 100|
|                | 70  | 90  | 48%| 17%| 39%| 41%| 52%| 61%| 70%| 85%| 95%| 100| 100| 100| 100| 100| 100|
|                | 90  | 110 | 48%| 23%| 36%| 44%| 52%| 63%| 72%| 72%| 73%| 73%| 72%| 71%| 71%| 71%| 71%|
|                | 110 | 130 | 48%| 34%| 53%| 70%| 84%| 57%| 100| 100| 100| 100| 100| 100| 100| 100| 100|
|                | 130 | 150 | 48%| 35%| 54%| 71%| 80%| 90%| 100| 100| 100| 100| 100| 100| 100| 100| 100|
|                | 150 | 170 | 48%| 35%| 53%| 88%| 63%| 98%| 100| 100| 100| 100| 100| 100| 100| 100| 100|
|                | 170 | 190 | 48%| 46%| 59%| 86%| 74%| 77%| 70%| 76%| 76%| 75%| 71%| 68%| 65%| 62%| 56%|
|                | 190 | 210 | 48%| 52%| 61%| 66%| 67%| 66%| 57%| 50%| 46%| 42%| 42%| 42%| 42%| 39%| 39%|
|                | 210 | 230 | 48%| 51%| 60%| 65%| 69%| 54%| 62%| 54%| 49%| 45%| 42%| 42%| 43%| 42%| 38%|
|                | 230 | 250 | 48%| 30%| 29%| 28%| 25%| 22%| 20%| 15%| 13%| 14%| 16%| 17%| 15%| 12%| 12%|
|                | 250 | 270 | 48%| 11%| 13%| 13%| 12%| 12%| 11%| 9% | 8% | 8% | 6% | 6% | 6% | 8% | 8% |
|                | 270 | 290 | 48%| 14%| 13%| 12%| 11%| 10%| 10%| 9% | 8% | 8% | 6% | 6% | 6% | 8% | 8% |
|                | 290 | 310 | 48%| 34%| 34%| 35%| 30%| 27%| 24%| 16%| 15%| 14%| 15%| 17%| 20%| 15%| 15%|
|                | 310 | 330 | 48%| 36%| 43%| 47%| 50%| 51%| 46%| 46%| 43%| 40%| 36%| 37%| 37%| 37%| 37%|
|                | 330 | 350 | 48%| 48%| 54%| 56%| 60%| 61%| 61%| 60%| 57%| 55%| 54%| 53%| 51%| 50%| 47%|

*Local anemometer wind speed*
Laboratory Exhaust

107 EUI

After exhaust control
Creating a better environment

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Project Engineer

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