HIGH-PERFORMING COLLABORATION: The Collaborative Life Sciences Building’s path to high-performance Design and Construction

Mark Williams, OHSU
George Hager, SERA Architects
Mike Custer, JE Dunn Construction
John McMichael, Interface Engineering
LEARNING OBJECTIVES

1. Explore the importance of synergy between institutional partners and learn how three major Oregon Universities came together to create a unique learning environment.
2. Understand the early design decisions and strategies that influenced the energy performance of this building.
3. Learn what choices accomplished the building’s mission and set the project up for success.
4. Understand how data-driven design helped mechanical and electrical systems achieve energy performance goals, and explore a comparison between the systems’ modeled and actual performance.
5. Learn the importance of collaboration throughout this project and discover how the team worked together to overcome challenges during design and construction.
AGENDA

- Project overview and vision
- Design process
- Project procurement and delivery
- Data driven design and project results
- Learning forward
History of the site
Location and campus information/ plan for OHSU
Partnerships
Team and Philosophy
Timeframe and accomplishment
HISTORY
LOCATION

• Portland South Waterfront Neighborhood
• 1st building on OHSU Schnitzer Campus
• 2 block construction site (650,000 GSF)
UNIQUE PARTNERSHIP

3 Higher Ed Institutions
(OHSU, OSU, PSU)
- Challenges: Different student populations, different business models, different technical design standards
- Benefits: Promotes innovative sustainability at each campus because each institution can share past successes and experience that allows staff to look at sustainability in a new light.

3 person steering committee
- One from each institution
- Empowered to make decisions
- And they did!
Owners

... along with 100s of Users

Owners’ Rep

... along with several consultants

Design Team

... along with 18 Consultants including Interface, KPFF, OTAK and Mayer-Reed

CMGC Contractor

... along with 8 Best-Value Subs including Harmon, Deamor, Skyline, Temp Control, JH Kelly, OEG, Western States, KONE
COLLABORATIVE LIFE SCIENCES BUILDING

• $295 million
• Multi-modal hub
• Brownfield Development
SCHEDULE

A/E Contract
May 2011

Substantial Completion
June 2014

37 MOs
Design Process- GH

Site design and orientation
Early design decisions
Program components
Jurisdiction and project schedule
Design elements
SITE ANALYSIS
ZONING ENVELOPE

View Corridors
Podium Height 75’
Tower Height 250’
Tower Zone Restrictions
SITE ANALYSIS
DATA DRIVEN MASSING

SOLAR ACCESS ANALYSIS

Original Proposal
By Previous Team

Final Massing
SOLAR ACCESS
SOLAR ACCESS
MASSING STUDY
MASSING STUDY
MASSING STUDY
EXTERIOR WALLS

EXISTING GRADE – CONTAMINATED SOILS
INTER-PROFESSIONAL EDUCATION
## PROJECT PROGRAM

<table>
<thead>
<tr>
<th>INSTITUTIONS</th>
<th>OHSU</th>
<th>PSU UNDERGRAD SCIENCE</th>
<th>OUS PHARMACY</th>
<th>SHARED</th>
<th>TOTAL</th>
<th>%</th>
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<td>DENTAL</td>
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<td>Lecture</td>
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<td>Learning Studio</td>
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<td>6,800</td>
<td>2,300</td>
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<td>1,875</td>
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<td>Teaching Lab</td>
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<td>26,400</td>
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<td>26,400</td>
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<td>Simulation</td>
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<td>11,180</td>
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<td>21,770</td>
<td>7.3%</td>
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<td>Community Life</td>
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<td>20,190</td>
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<td>20,190</td>
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<td>Clinic</td>
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<td></td>
<td>53,750</td>
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<td>53,750</td>
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<tr>
<td>Faculty</td>
<td></td>
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<td>18,330</td>
<td>6%</td>
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<td>Building Support</td>
<td>11,770</td>
<td>10,430</td>
<td>8,160</td>
<td>4,100</td>
<td>32,460</td>
<td>10.7%</td>
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<td>INSTITUTIONAL TOTAL</td>
<td><strong>104,560</strong></td>
<td>38,000</td>
<td><strong>16,955</strong></td>
<td>49,485</td>
<td><strong>297,280</strong></td>
<td><strong>66%</strong></td>
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</table>

OUS/OHSU Collaborative Life Sciences Building and OHSU Skourtes Tower
HIGH PERFORMING COLLABORATION
May 26, 2016
PROJECT PROGRAM

- OHSU School of Dentistry & Dental Clinic
- PSU’s biology and chemistry lecture halls and laboratories
- OHSU’s School of Medicine, physician assistants and radiation technologists
- OSU’s College of Pharmacy
- Medical Simulation Center
- OHSU Center for Spatial Systems Biomedicine

- Labs for research in basic and applied science and engineering
- Shared instrumentation labs with electron microscopy, NMR and other specialized sophisticated instrumentation
- Ground Floor retail space
- 400 space parking garage with bicycle parking & lockers/showers
PROJECT PROGRAM

Small group rooms  Standardized  Simulation rooms  Study rooms  Lounges  Faculty Offices
Classrooms  Patient Room  Control rooms  Seating areas  Food service  Admin offices
Learning studios  Brief/De-Brief  SP exam rooms  Classrooms  kitchenettes  Conference Rooms
Lecture halls  Exam Rooms  Classrooms  Terminals  Lockers/mailboxes  Workrooms
Teaching labs  Monitoring Room  Debrief  Reserves  Lobbies/galleries
Staff Offices  Staff offices  Stacks  Exterior space  Student orgs/gov’t

CLASSROOMS  CLINICAL SKILLS  SIMULATION  LIBRARY  COMMUNITY SPACE  ADMIN / SUPPORT
PROGRAM STACKING

EXISTING GRADE – CONTAMINATED SOILS
EXAMPLE FLOOR PLANS

Level 1

Level 3
PROGRAM GOALS
PROGRAM GOALS
PROGRAM GOALS
PROGRAM GOALS
PROGRAM GOALS
PROGRAM GOALS
PROGRAM GOALS
PROGRAM GOALS
Project Procurement and Delivery- MC

Technology in Construction
Co-location
Collaborative Technology
BUILDING INFORMATION MODEL - CONSTRUCTION
BIM AND THE SCHEDULE

✓ $1.5M cost avoidance by casting the ~55,000 MEP systems hangers into concrete slabs 5 months before official construction documents issued.
BIM DURING CONSTRUCTION
BIM DURING CONSTRUCTION

J.H. Kelly
Rack Assembly I
Lift/ Crane to Floor (Manitou)

J.H. Kelly
Rack Cart (x3 racks / cart)
Delivery to each floor

OUS/OHSU Collaborative Life Sciences Building and OHSU Skourtes Tower
HIGH PERFORMING COLLABORATION

May 26, 2016
BIM DURING CONSTRUCTION
BIM DURING CONSTRUCTION

J.H.Kelly
Rack Assembly Installation
Field Connections Ready

J.H.Kelly
Rack Assembly Installation
Prep for final connections
CO-LOCATION

BETTER COMMUNICATION
✓ Highly coordinated overall design.
✓ Fewer assumptions made by disconnected design team members.
✓ More spontaneous design coordination discussions.
✓ Better understanding of other disciplines’ work flows and design problems.

LESS WASTED TIME
✓ Less time spent waiting for answers from email and voicemail.
COLLABORATION TECHNOLOGY

- Design, Analysis, & Documentation
  - Autodesk Revit
  - Rhinoceros
  - AGi32 Lighting Software
  - Google Sketchup
  - ecotect

- Coordination & Information Management
  - ideate BIMLink
  - bluebeam
  - smartsheet
  - Newforma
  - Microsoft SharePoint
  - e-BUILDER
  - onehub
  - Dropbox

- File Sharing
**ELECTRONIC DOCUMENTS – CLSB CASE STUDY**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Estimated Cost</th>
<th>Note</th>
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<tr>
<td>Document Reproduction Costs</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Quantity of drawings for entire set</td>
<td>EA</td>
<td>1,954</td>
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<td>Average time each sheet issued</td>
<td>EA</td>
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<td>Quantity of total sheets issued</td>
<td>EA</td>
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<td>Quantity of drawing sets for Subcontractors, Owners, Design Team Construction Team</td>
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<td>Assume on ave that 50% of the sheets are issued.</td>
<td>EA</td>
<td>100</td>
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<tr>
<td>Total sheets issued</td>
<td>EA</td>
<td>1,387,800</td>
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<td>Cost for document printing 1/2 size drawings</td>
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<td>1.02</td>
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<td>Cost for document printing full size drawings</td>
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<td>$2,092,734</td>
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<td>Posting time (Document updates)</td>
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<tr>
<td>Drawing sheets issued (Addenda &amp; AB)</td>
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<td>Quantity of sets being updated</td>
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<td>Quantity of manhours to post (Addenda &amp; AB)</td>
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<td>97,700</td>
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<td>Ave Cost/Manhour</td>
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<tr>
<td>RFI Posting</td>
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<td>Total RFI posted</td>
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<td>Quantity of sets being updated</td>
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<td>HRS</td>
<td>15,500</td>
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<tr>
<td>Ave Cost/Manhour</td>
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<tr>
<td>Operations and Maintenance Manuals</td>
<td>HRS</td>
<td>520</td>
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<td>$415,048</td>
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<td>Estimate 3 months of full time person</td>
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<td></td>
<td></td>
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<tr>
<td>Ave Cost/Manhour</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Deduct full time updates by JE Dunn</td>
<td>HRS</td>
<td>-4,844</td>
<td>79.00</td>
<td>($386,676)</td>
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<tr>
<td>Total Estimated Project Cost Savings</td>
<td></td>
<td></td>
<td>$9,996,328</td>
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</table>

**Saves over 110,000 manhours**

**Nearly $10M in cost savings!**
Collaborative Technology

Coordination & QA/QC

Bluebeam Revu used for electronic submittals. Simultaneous, coordinated review.
Collaborative Technology

Hyperlinked PDF project documents make finding information fast and easy.

Drawings
Specifications
Submittals
O&M Manuals
Photo Maps
ELECTRONIC DOCUMENTS IN POST CONSTRUCTION
Data Driven Design and Project Results - JM

Goals
Energy Conservation Measures
LEED Summary
Water Savings
Incentives
Actual data
Recognition
SUSTAINABILITY

PROJECT GOALS

• LEED PLATINUM (A/E/C TEAM INCENTIVIZED)
• ECO-DISTRICT READY BUILDING
• GREEN ROOFS AND RAIN WATER CAPTURE FOR NON-POTABLE USES
• 30% MORE EFFICIENT THAN CODE (COST BASIS)
• HIGH PERFORMANCE HEATING AND COOLING SYSTEMS (HEAT RECOVERY, RADIANT HEATING AND COOLING SURFACES, DISPLACEMENT VENTILATION, ENERGY EFFICIENT LIGHTING)
• HEALTHY MATERIALS THAT ENHANCE INDOOR AIR QUALITY
SUSTAINABILITY

STRATEGIES AND SAVING
ATTACK LARGER ENERGY USE AREAS FIRST

- FUME HOOD SASH MANAGEMENT
- AIR FLOW REDUCTION
- HEAT RECOVERY
- CASCADE AIR SYSTEMS
- HYDRONIC/RADIANT SYSTEMS
- DAYLIGHTING
- GOOD ENVELOPE
- ENERGY EFFICIENT LIGHTING

ANNUAL ENERGY SAVINGS: $450,000
Using 2013 energy costs
ENERGY REDUCTION
Energy Conservation Measures

Heat Recovery Chiller
Radiant Heating/Cooling
Atrium Heat Recovery
Daylighting
Evaporative Humidification
Heating Loads in Series
Single Coil AHU
Variable Volume Lab Exhaust
Lab Exhaust Heat Recovery
High Efficiency Condensing Boilers
Low Flow Fume Hoods
Energy Conservation Measures

Atrium Heat Recovery
Daylighting
ENERGY CONSERVATION

45% ENERGY SAVINGS

- SERIES HOT WATER COILS
- TERMINAL HEATING UNITS
- HEAT RECOVERY CHILLER
- INCREASES EFFICIENCY
- HOT WATER FROM PLANT
- 140°F
- HOT WATER RETURN
- 90°F
- ADDITIONAL HEAT RECOVERED
- LAB FREEZERS & EXHAUST
- AIR HANDLING COILS
- SUPPLIED BY WATER
Energy Conservation Measures

Heating Loads in Series

[Diagram of heating loads in series with labels for terminal units coils (130F-100F), air handler coils (100F-80F), boilers, heat recovery chiller, and terminals.]
Energy Conservation Measures

Evaporative Humidification
## ENERGY REDUCTION COST BENEFIT ANALYSIS

<table>
<thead>
<tr>
<th>DESCRIPTION OF MEASURE</th>
<th>CAPITAL COST ESTIMATE</th>
<th>POTENTIAL INCENTIVE FUNDING</th>
<th>NET COST AFTER INCENTIVES</th>
<th>ENERGY SAVINGS (KWH) OR WATER SAVINGS (GALS)</th>
<th>ANNUAL OPERATING SAVINGS</th>
<th>SIMPLE PAYBACK (YEARS)</th>
<th>OWNER VALUE</th>
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<tbody>
<tr>
<td>Add Shading Devices</td>
<td>$22,000</td>
<td>$6,600</td>
<td>$15,400</td>
<td>50,000 kWh</td>
<td>$3,500</td>
<td>4.4</td>
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<tr>
<td>Heat Recovery Ventilation</td>
<td>$280,000</td>
<td>$84,000</td>
<td>$196,000</td>
<td>33,000 therms</td>
<td>$33,000</td>
<td>5.9</td>
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<td>Occupancy Sensors</td>
<td>$31,600</td>
<td>$9,480</td>
<td>$22,120</td>
<td>55,000 kWh</td>
<td>$3,500</td>
<td>6.3</td>
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<td>Low Velocity Variable Volume Fume Hoods</td>
<td>$1,350,000</td>
<td>$240,000</td>
<td>$1,110,000</td>
<td>900,000 kWh, 60,000 therms</td>
<td>$123,000</td>
<td>9</td>
<td>Higher velocity. Improved comfort with higher ventilation rate.</td>
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<td>Well Water Heat Pump</td>
<td>$1,250,000</td>
<td>$100,000</td>
<td>$1,150,000</td>
<td>100,000 therms</td>
<td>$100,000</td>
<td>11.5</td>
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<tr>
<td>Operable Windows</td>
<td>$105,000</td>
<td>$10,000</td>
<td>$95,000</td>
<td>70,000 kWh</td>
<td>$4,900</td>
<td>19.4</td>
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<td>Chilled Beams for Localized Cooling</td>
<td>$462,000</td>
<td>$30,000</td>
<td>$432,000</td>
<td>200,000 kWh, 5,000 therms</td>
<td>$19,000</td>
<td>22.7</td>
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<td>Radiant Heat w/ Displacement Ventilation</td>
<td>$358,509</td>
<td>$26,000</td>
<td>$332,509</td>
<td>100,000 kWh, 6,000 therms</td>
<td>$13,000</td>
<td>25.6</td>
<td>Superior comfort. Quieter environment. Improved ventilation. Better air quality.</td>
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<td>Solar Thermal Panel System</td>
<td>$375,000</td>
<td>$30,000</td>
<td>$345,000</td>
<td>10,000 therms</td>
<td>$10,000</td>
<td>34.5</td>
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RESULTS

OHSU/OHSU Collaborative Life Sciences Building and OHSU Skourtes Tower
HIGH PERFORMING COLLABORATION

May 26, 2016
RESULTS
STORMWATER REDUCTION

GREEN ROOF
PROMOTE HABITAT
REDUCE SITE RUNOFF

20%
RESULTS
RAINWATER HARVESTING

[Diagram of rainwater harvesting system with text: 60% POTABLE WATER REDUCTION]
LEED RESULTS

**platinum**

SUBMITTED:

83 pts

ACHIEVED:

80 pts

Approved Design Pts = 48
Approved Construction Pts = 32

Tracking Key Points:

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<th>FINAL</th>
<th>Threshold</th>
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<td>Recycled Content (2)</td>
<td>29.7%</td>
<td>20%</td>
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<tr>
<td>Regional Materials (2)</td>
<td>22.7%</td>
<td>20%</td>
</tr>
<tr>
<td>Construction Waste Mgmt (2)</td>
<td>85.1%</td>
<td>75%</td>
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<tr>
<td>FSC Wood (2)</td>
<td>74.0%</td>
<td>50%</td>
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## INCENTIVE RESULTS

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<tr>
<th>Incentive</th>
<th>Amount</th>
<th>Status</th>
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<tr>
<td>ETO Early Design Assistance</td>
<td>$1,200</td>
<td>PAID</td>
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<tr>
<td>ETO Energy Modeling</td>
<td>$25,000</td>
<td>PAID</td>
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<tr>
<td>ETO Incentive</td>
<td>$499,999</td>
<td>PAID</td>
</tr>
<tr>
<td>ETO Commissioning</td>
<td>$40,000</td>
<td>PAID</td>
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<tr>
<td>City of PDX Green Roof Incentive</td>
<td>$82,150</td>
<td>PAID</td>
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<tr>
<td>ODOE EIP (pass-thru tax credit)</td>
<td>est $370,000</td>
<td>Final Steps</td>
</tr>
</tbody>
</table>
RESULTS - 12 MONTH DATA

CLSB Natural Gas: Actual vs Modeled

- Natural Gas Modeled
- Natural Gas Actual

Natural Gas Usage (therms)

- Jul-14
- Aug-14
- Sep-14
- Oct-14
- Nov-14
- Dec-14
- Jan-15
- Feb-15
- Mar-15
- Apr-15
- May-15
- Jun-15
- Jul-15
- Aug-15
RESULTS - 12 MONTH DATA

CLSB Total Energy: Actual vs Modeled

Total Energy Usage (KWh)

- Total Energy Modeled
- Total Energy Actual

Month:
- Jul-14
- Aug-14
- Sep-14
- Oct-14
- Nov-14
- Dec-14
- Jan-15
- Feb-15
- Mar-15
- Apr-15
- May-15
- Jun-15
- Jul-15
- Aug-15
RESULTS - 12 MONTH DATA

\[ \text{GROSS BUILDING AREA} = \text{EUI} \times \left( \frac{\text{NATURAL GAS}}{\text{ELECTRICITY}} - \text{RENEWABLES} \right) \]

\[ \text{EUI} \text{ kBTU/SF/YR} \]
RESULTS - 12 MONTH DATA

CLSB EUI

197 Base EUI

110 Modeled EUI

79* Actual EUI (kBTU/sf/yr)
(Sep 14 - Aug 15)

*Factors:
1. LEED Requires modeling at full build.
2. East Retail not yet occupied.
3. 7th floor research lab remains a shell space.
4. Early occupancy low density.
• LEED Platinum
• AIA COTE Top Ten (2015)
• AIA TAP Honorable Mention for Delivery Process Excellence (2015)
• SCUP/AIA-CAE Excellence in Architecture Merit Award (2015)
• ENR Northwest's Best Project of 2015 for Higher Education Research
LEARNING FORWARD

COLLABORATIVE PARTNERSHIPS - AT A VARIETY OF SCALES - HAVE POTENTIAL TO YIELD MANY BENEFITS
LEARNING FORWARD

ADAPTABILITY WITHIN CONSTRAINTS
LEARNING FORWARD

SUSTAINABILITY ON DISPLAY
QUESTIONS