Spring 2015 ARCH 4272/6372
WHOLE BUILDING ENERGY MODULE
What is your design process for high performance buildings?
Energy Considerations General

› Climate
  › Hot/Cold
  › Dry/Humid

› Massing
  › Perimeter/Core Ratio

› Orientation
  › Daylighting/Glare
  › Window-to-Wall Ratio
  › Infiltration/Exfiltration
Energy Considerations  Envelope

- Exterior Wall (above & below grade)
  - Window
    - U-Value
    - SHGC
    - VT
    - Shading
  - Insulation
  - Reflectance
  - Exterior Doors
    - Insulation
- Roof
  - Skylight
    - U-Value
    - SHGC
    - VT
  - Insulation
  - Reflectance
- Exterior Floor
  - Insulation
- Slab Insulation
Energy Considerations Lighting

› Lighting (exterior and interior)
  › Lamp Type
  › Light Levels
  › Controls
    › Occupancy
    › Daylighting
  › Interior Surface Reflectance
Energy Considerations

› Passive
  › See Diagram

› Active
  › Packaged Units (DX)
  › VAV w/ Reheat
  › Chilled Beam
  › VRF System
  › Central Plant
Energy Considerations Plug/Misc

- Equipment
  - Elevators/Escalators
  - Transformers

- Outlets
  - Vampire Loads
    - Computers
    - Task Lights

- Domestic Hot Water (DHW)
Idea Generators

**LBNL**
Climate Consultant
- Psychometric Chart
- Diagrams
http://www.energy-design-tools.aud.ucla.edu/

**Department of Energy**
Infographics
- Facts
http://energy.gov/

**ASHRAE**
Advanced Energy Design Guide (AEDG)
- Whole Building
https://www.ashrae.org/standards-research--technology/advanced-energy-design-guides
Case Study_1

SALT LAKE CITY LIBRARY
GLENDALE BRANCH
Location
Salt Lake City, Utah
Report

Target Report

Executive Summary
The following report outlines the energy baseline for the new Salt Lake City Glendale Library. The report provides key building statistics including peak HVAC loads (airflow, heating, and cooling), a breakdown of utility cost by end use, and overall annual energy consumption.

Baseline Description
The energy code baseline is ASHRAE 90.1-2007 following the modeling methodology of ASHRAE 90.1-2007, Appendix G, with addenda.

Target Finder, the EPA’s energy performance program does not include libraries, baseline verification was accomplished using the Commercial Buildings Energy Consumption Survey (CBECS) of 2003. CBECS states the median site EUI for a public assembly occupancy to be 90.8 kBtu/SF/year which is within 14.2% of the baseline model.

Baseline Whole Building Energy Consumption

<table>
<thead>
<tr>
<th>Item</th>
<th>Electric</th>
<th>Natural Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kBtu/year)</td>
<td>Demand (Average kW/yr)</td>
<td>Cost ($)</td>
</tr>
<tr>
<td>Heating</td>
<td>20,000</td>
<td>15</td>
</tr>
<tr>
<td>Lighting</td>
<td>4,100</td>
<td>4,100</td>
</tr>
<tr>
<td>HVAC</td>
<td>1,300</td>
<td>1,300</td>
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<tr>
<td>Office Use</td>
<td>2,000</td>
<td>2,000</td>
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<tr>
<td>Data Center</td>
<td>3,500</td>
<td>3,500</td>
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<tr>
<td>Total</td>
<td>31,500</td>
<td>2,900</td>
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</table>

Target Report

27% Energy Cost Savings

Executive Summary
This target report represents the culmination of all of the EEMSs that were evaluated for this project. The combined effect of the EEMSs produces an estimated 27% savings over code minimum with a simple payback of 5.7 years.

Energy Efficiency Measures
Envelope was modeled with 47% Window-to-Wall Ratio (7% worse than code)
Wall Assembly was modeled with a thermal resistance of R-17 (R-10 c.i. & R-13 batt).
Roof Assembly was modeled with a thermal resistance of R-27-4 and 70% reflectance.
Window Assembly were modeled with Viracon Vue 1.50 glass and thermally broken aluminum frames.
The lighting systems were modeled to achieve an overall design lighting power density (LPD) of 1.04 Watts/ft².
Occupancy based controls were modeled to turn off lights when spaces are unoccupied; these controls were modeled in 25% of the building area.
Daylight harvesting controls were modeled to automatically reduce lighting power in perimeter spaces where adequate daylight penetration exists.
HVACs upgrades include 8 roof top units ranging from EER 10.3 to EER 15.
Case Study_2

MANITOBA HYDRO
Location

Winnipeg, Manitoba
Diagrams
Localized Air Flow
Double Wall/Space Comfort
## Passive Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Reason</th>
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</thead>
<tbody>
<tr>
<td>High Ceiling</td>
<td>Natural Light</td>
</tr>
<tr>
<td>Low Iron Windows</td>
<td>Maximum Solar Gain</td>
</tr>
<tr>
<td>Double Exterior Wall</td>
<td>Buffer against Extreme Climate</td>
</tr>
<tr>
<td>Operable Vents</td>
<td>Natural Ventilation</td>
</tr>
<tr>
<td>Operable Interior Windows</td>
<td>Ventilation</td>
</tr>
<tr>
<td>Automated Solar Shades</td>
<td>Load Control</td>
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<tr>
<td>South Facing Winter Garden</td>
<td>Preconditions Air</td>
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Passive Features Cont.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geothermal Heating/Cooling</td>
<td>Renewable Energy Source</td>
</tr>
<tr>
<td>Solar Chimney</td>
<td>Natural Ventilation</td>
</tr>
<tr>
<td>Exhaust Recovery Ventilator</td>
<td>Reuse of Energy</td>
</tr>
<tr>
<td>Under Floor Air Distribution</td>
<td>System Efficiency</td>
</tr>
<tr>
<td>Efficient Lights w/ Occupancy Sensor</td>
<td>Lower Loads</td>
</tr>
<tr>
<td>Massing for Solar Benefit</td>
<td>Passive Load Control</td>
</tr>
<tr>
<td>Waterfall for Humidity Control</td>
<td>Natural Conditioning</td>
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$283,000,000
THE BRIDGE
# Code Compliance vs. Building Performance

<table>
<thead>
<tr>
<th>Code</th>
<th>Building Performance</th>
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<tbody>
<tr>
<td>COMCheck</td>
<td>LEED</td>
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<tr>
<td>RESCheck</td>
<td>Green Globe</td>
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<tr>
<td>ASHRAE 90.1</td>
<td>HERS</td>
</tr>
<tr>
<td>ASHRAE 90.2</td>
<td>ASHRAE 189</td>
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<tr>
<td>IECC</td>
<td>International Living Future</td>
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### Whole Building Energy Modeling vs. Component Modeling

<table>
<thead>
<tr>
<th>Whole Building</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOE 2.2 – eQUEST</td>
<td>DIVA for Rhino – Lighting</td>
</tr>
<tr>
<td>HEED</td>
<td>AGi32 – Lighting</td>
</tr>
<tr>
<td>IES-VE</td>
<td>THERM – Wall Assembly</td>
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<tr>
<td>Trane Trace</td>
<td>SymScape - CFD</td>
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<tr>
<td>HAP</td>
<td></td>
</tr>
<tr>
<td>EcoTECT</td>
<td></td>
</tr>
<tr>
<td>Sefaira</td>
<td></td>
</tr>
</tbody>
</table>
eQUEST walk through

› No CFD Analysis
› HVAC system type limitation
› Split Flux Daylighting Method
› No Thermal Massing
Sefaira walk through

› Orientation
› Massing
› Window-to-Wall Ratio
› Envelope Insulation Values
› Window Selection
› Skylight Selection/Placement
› Exterior Shading
Questions?