Learning Objectives

At the end of this program, participants will be able to:

1. Understand what the 7 petals and 20 imperatives of the Living Building Challenge (LBC) are.
2. Understand the challenges of Type-4 Heavy Timber construction type and the benefits it offers in a low-carbon, high performance building.
3. Understand the strategies employed by the design team to achieve a net-zero energy, water and waste.
4. Understand the complexities inherent in meeting the materials red list and radius requirements of the LBC.
URBAN
SINGLE
FAMILY
PUBLIC BUILDINGS

LIVING BUILDINGS
U.S. Energy Consumption by Sector

- Industry 22.7% (21.7 QBTu)
- Transportation 28.2% (27.0 QBTu)
- Buildings 49% (46.9 QBTu)
- Building Operations 77% (29.99 QBTu)


U.S. Electricity Consumption by Sector

- Industry 23% (8.96 QBTu)
- Transportation <1% (0.07 QBTu)
- Buildings 46.9% (2580 MMT CO₂e)
- Building Operations 77% (29.99 QBTu)

The Living Building Challenge™ 2.0

1. **SITE**
   Limits to Growth, Urban Agriculture, Habitat Exchange, Car Free Living

2. **WATER**
   Net Zero Water, Ecological Water Flow

3. **ENERGY**
   Net Zero Energy

4. **HEALTH**
   Civilized Environment, Healthy Air, Biophilia

5. **MATERIALS**
   Redlist, Embodied Carbon Footprint, Responsible Industry, Materials Radius, Conservation & Reuse

6. **EQUITY**
   Human Scale + Human spaces, Democracy + Social Justice, Rights to Nature

7. **BEAUTY**
   Beauty and Spirit, Inspiration and Education
Cascadia Center
McGilvra Place

determining the CARRYING CAPACITY of the site:
solar harvest 230,000 kW h/year
gross building area 52,000 g
Energy Use Index (EUI) 16

Energy Efficiency Measures

<table>
<thead>
<tr>
<th>Energy Use (kWh)</th>
<th>400,000</th>
<th>500,000</th>
<th>600,000</th>
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</thead>
<tbody>
<tr>
<td>SPACE COOLING</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPACE HEATING</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MISC EQUIP</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>IT SERVER</td>
<td>0</td>
<td></td>
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<tr>
<td>LIGHTS</td>
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</table>

EUI – Energy Use Index

Energy Efficiency Measures

SOLAR
DOMEST HOT WTR
ELEVATOR
VENT FANS
PUMPS & AUX
SPACE COOLING
SPACE HEATING
MISC EQUIP
IT SERVER
LIGHTS

85% SAVINGS

Net Zero
Energy Consumption

Proposed Building Energy Use

Typical Building

Proposed Building

<table>
<thead>
<tr>
<th>Energy Consumption</th>
<th>Proposed Building Energy Use</th>
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</thead>
<tbody>
<tr>
<td><strong>Total Savings</strong></td>
<td>75%</td>
</tr>
<tr>
<td><strong>Heating</strong></td>
<td>10%</td>
</tr>
<tr>
<td><strong>Cooling</strong></td>
<td>7%</td>
</tr>
<tr>
<td><strong>Electrical</strong></td>
<td>13%</td>
</tr>
<tr>
<td><strong>Plumbing</strong></td>
<td>4%</td>
</tr>
<tr>
<td><strong>Lighting</strong></td>
<td>10%</td>
</tr>
<tr>
<td><strong>Tenant Savings</strong></td>
<td>5%</td>
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</tbody>
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<td><strong>Lighting</strong></td>
<td>10%</td>
</tr>
<tr>
<td><strong>Tenant Savings</strong></td>
<td>5%</td>
</tr>
</tbody>
</table>

- Heat: 40%
- Cooling: 7%
- Electrical: 25%
- Plumbing: 5%
- Lighting: 15%
- Tenant Savings: 10%
- Total Savings: 75%

- Heating: 10%
- Cooling: 7%
- Electrical: 13%
- Plumbing: 4%
- Lighting: 10%
- Tenant Savings: 5%
- Total Savings: 75%

- Space Heating: 2%
- Domestic Hot Water: 1%
- Pumps/Aux: 1%
- Elevator: 1%
- Fans: 1%
- Miscellaneous: 1%
- Lights: 23%
- IT Servers: 10%
- Domestic Hot Water: 4%
- Space Cooling: 2%
Daylighting Simulation: Effect of Atrium - Uniform Overcast Skies
No “Height Departure”

11'-6” floor to floor

77% of the floor area has daylight levels below 2%

Proposed Plan with “Height Departure”

14'-2” floor to floor

38% of the floor area has daylight levels below 2%
Meeting room

No skylight

50% skylight

Skylight
Scheme 2 - FLAT ROOF ARRAY (15 deg tilt @ Back):

ROOF (5 deg West) = 11,573sf = 187,000 kWh/yr
SOUTHEAST WALL = 750sf = 9,000 kWh/yr
SOUTH WALL = 4,015sf = 50,000 kWh/yr (3,500kWh/yr/row)

246,000 kWh/yr (BASE)

July 28, 2009

Scheme 2 - TILTED ROOF ARRAY (15 deg tilt @ Back):

ROOF (5 deg West) = 7,258sf = 123,000 kWh/yr
ROOF (15 deg Southeast) = 4,240sf = 73,000 kWh/yr
SOUTHEAST WALL = 750sf = 9,000 kWh/yr
SOUTH WALL = 4,015sf = 50,000 kWh/yr (3,500kWh/yr/row)

255,000 kWh/yr (+9K v. BASE)

July 28, 2009
Scheme 4B – DOUBLE TILTED ROOF ARRAY (10 & 25 deg tilt):

July 28, 2009

**ROOF (20 deg Southeast) =** 6,522sf = 114,500 kWh/yr
**ROOF (25 deg Southeast) =** 4,115sf = 73,000 kWh/yr
**WEST WALL =** 1,384sf = 14,000 kWh/yr
**SOUTH WALL =** 3,915sf = 48,500 kWh/yr (3,500 kWh/yr/row)

**250,000 kWh/yr (+5K v. BASE)**

July 28, 2009

**SOUTHEAST WALL =** 1,023sf = 12,000 kWh/yr
**WEST WALL =** 786sf = 8,000 kWh/yr
**SOUTH WALL =** 4,015sf = 50,000 kWh/yr (3,500 kWh/yr/row)

**264,000 kWh/yr (+19K v. BASE)**

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Scheme 6 – FOLDED ROOF ARRAY (10 & 25 deg tilt):

**ROOF (5 deg Southwest) =** 3,068sf = 50,500 kWh/yr
**ROOF (10 deg Southwest) =** 8,542sf = 143,500 kWh/yr
**SOUTHEAST WALL =** 786sf = 8,000 kWh/yr
**WEST WALL =** 511sf = 5,500 kWh/yr
**SOUTH WALL =** 2,918sf = 36,000 kWh/yr

**SOUTH WALL =** 4,015sf = 50,000 kWh/yr (3,500 kWh/yr/row)

**264,000 kWh/yr (+19K v. BASE)**

---

Scheme 1a – South Spaced 10.5” (15 deg tilt @ North Roof):

**ROOF SOUTH (5 deg West):** 6,272sf = 101,500 kWh/yr (503 panels)
**ROOF MIDDLE (5 deg West):** 611sf = 10,000 kWh/yr (49 panels)
**ROOF NORTH (5 deg East & 15 deg SE):** 4,539sf = 78,500 kWh/yr (364 panels)
**SOUTH WALL:** 2,918sf = 36,000 kWh/yr (234 panels)

**Sliding roof section:** 1,048sf * 75% = 785sf = 12,000 kWh/yr (84 panels)

**524sf * 70% = 367sf:** 7,000 kWh/yr (42 panels)

**524sf * 70% = 367sf:** (150 panels)

**511sf = 5,500 kWh/yr:** (50 panels)

**511sf = 5,500 kWh/yr:** (50 panels)

**511sf = 5,500 kWh/yr:** (50 panels)

**261,000 kWh/yr**

---

August 12, 2009
A typical building of this size has an Energy Use Intensity of 72 kBtu/ft²/year. A PV array with an area of 64,348 ft² is required to meet its energy needs.

A building of this size meeting Seattle Energy Code has an EUI of 51 kBtu/ft²/year requiring a PV array with an area of 44,752 ft² to meet its energy needs.

A LEED Platinum certified building of this size has an EUI of 32 kBtu/ft²/year requiring a PV array with an area of 28,599 ft² to meet its energy needs.

The proposed building, meeting the Living Building Challenge, has an EUI of 16 kBtu/ft²/year and needs only 14,303 ft² of PV to meet its net-zero energy goal.
Energy Conservation: Tenant

20" CFL-LCD: 75 watts
20" CFL-LCD: 75 watts

Total: 250 watts
Plug Loads | 2009

- 80 watts
- 22" CFL-LCD
- 40 watts
- 22" CFL-LCD

Total: 160 watts

Plug Loads | 2010

- 62 watts
- 22" LED-LCD
- 14 watts
- 22" LED-LCD

Total: 90 watts
MATERIALS

Endorsing products + processes that are safe for all species through time

The project cannot contain worst-in-class materials or chemicals, such as carcinogens, persistent organic pollutants, bioaccumulative toxins, and endocrine disruptors.

Asbestos
Cadmium
Chlorinated Polyethylene and Chlorosulfonated Polyethylene
Chlorofluorocarbons (CFCs)
Chloropropane (Neoprene)
Formaldehyde (added)
Halogenated Flame Retardants
Hydrochlorofluorocarbons (HCFCs)
Lead (added)
Mercury
Petrochemical Fertilizers and Pesticides
Phthalates
Polyvinyl Chloride (PVC)
Wood treatments containing Creosote, Arsenic or Pentachlorophenol

1 RED LIST

362 CHEMICALS
14 APPROPRIATE SOURCING

Source locations for materials and services must adhere to the following restrictions:

<table>
<thead>
<tr>
<th>ZONE</th>
<th>MAX DISTANCE</th>
<th>MATERIALS/SERVICES</th>
<th>MASTERFORMAT 2004 CLASSIFICATION</th>
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</thead>
<tbody>
<tr>
<td>7</td>
<td>20,000 km</td>
<td>Ideas</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>15,000 km</td>
<td>Renewable Technologies</td>
<td>Divisions: 42, 48</td>
</tr>
<tr>
<td>5</td>
<td>5,000 km</td>
<td>Assemblies that actively contribute to building performance + adaptable reuse once installed</td>
<td>Divisions: 08 (exterior), 11, 14, 22, 23, 25, 33, 44 Sections: 07 50 00, 10 21 23, 10 22 00, 10 70 00, 44 40 00</td>
</tr>
<tr>
<td>4</td>
<td>2,500 km</td>
<td>Consultant Travel</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2,000 km</td>
<td>Light or low-density materials</td>
<td>Sections: 07 31 00, 07 33 00, 07 40 00, 09 50 00, 09 60 00</td>
</tr>
<tr>
<td>2</td>
<td>1,000 km</td>
<td>Medium weight or density materials</td>
<td>Divisions: 06, 08 (interior) Sections: 07 32 00, 09 20 00, 09 30 00, 12 30 00</td>
</tr>
<tr>
<td>1</td>
<td>500 km</td>
<td>Heavy or high-density materials</td>
<td>Divisions: 03, 04, 05, 31, 32</td>
</tr>
</tbody>
</table>

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15 CONSERVATION + REUSE

All projects teams must strive to reduce or eliminate the production of waste during design, construction, operation, and end of life in order to conserve natural resources.

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Building at 15th & Madison before deconstruction photo: John Stamets
Boards are removed one at a time so they can be used again

photo: John Stanets
LIVING
CITY

THE LIVING CITY

FIGHT FOR YOUR RIGHT OF WAY
Questions?

This concludes The American Institute of Architects Continuing Education Systems Course

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The Miller Hull Partnership
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