Energy savings from Daylighting

Flash-estimating

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Outline:

1. Metrics
2. Rules of thumb
3. Use in Energy Calculation
4. Example case

Learning Objectives

1. Know the metrics for lighting.
2. Learn Reinhart’s Rules of thumb for pinning down a ”daylit area“.
Metrics

- Luminous flux: energy weighted by spectral sensitivity of the human eye [lumens]
- Illuminance: luminous flux/area [lumens/m² = lux, lumens/ft² = footcandles]
- Luminous intensity: luminous flux/solid angle [lumens/steradian = candela]
- Luminance = luminous intensity/area [candela/m²]
- Daylight autonomy, e.g. DA-300lux-50%
Rules of thumb

• Window-Head-Height (WHH)
  – Daylit Area Depth Approx. 1-2 x WHH
  – No dynamic shading system Approx. 2.5 x WHH

• Daylight Feasibility Test
  – Sky Angle (°) x WWR (%) > 2,000

• Atrium Max Height (not used for this example)
  – 2.5 x width
Test Method
Method

• WP tree node “Internal loads / Occupancy”
• Utilization Pattern tab: Make a pattern “Quick Daylighting”
  – Begin hour 8, End hour 18
  – 365 days/yr
  – 300 lux (might be overridden by LPD)
  – Utiliz. height 2.6 ft (0.8 m)
  – Relative absence 0.5
  – Partial use factor for lighting 1.0
Method

• WP tree node “Internal loads / Occupancy”
Method

• Determine daylit area(s) according to rules of thumb.
• Note room height.
• Note average/typical room width.
Room Height

- Note room height
  - Upper Level: 11’
  - Main Level: 10.5’
  - Lower Level: 10’

- Room Height: 10.5’
- WHH = 10.5’ – 1.5’ = 9’
Daylit Areas

• Determine Daylit Area according to rule of thumb
• 18’ in from perimeter (2x 9’ WHH)
• Upper Level – Flat Roof Area (Skylight potential)
Average Room Width

- Note average/typical room width
  - Lower Level: 34.5’
  - Main Level: 30’
  - Upper Level: 24’
Lighting tab entries

• Make entries for daylit area(s) AND the remaining non-daylit area as fraction of total floor area.
• Manual Control
• No Motion Detector
• Orientation South
• Light transmission 69%
• Daylit area(s)
  – Enter room height and average room width e.g. from inspection of plans.
  – Set Room depth = 2 x Room height
  – Set Lintel height = Room height minus 1.5 feet
  – Set Window width = 0.75 x Room width
• Remaining non-daylit area
  – Set Room Width = Room Depth = Room height
  – Uncheck “façade including windows”
• Temporarily Uncheck “façade including windows” for the daylit areas in order to get “without-daylighting” energy use and compute % reduction by daylighting.
# Lighting tab entries

<table>
<thead>
<tr>
<th>Name</th>
<th>Utilization pattern</th>
<th>Fraction of conditioned floor area [-]</th>
<th>Derivation from north [°]</th>
<th>Light transmission glazing</th>
<th>Room depth [ft]</th>
<th>Room width [ft]</th>
<th>Room height [ft]</th>
</tr>
</thead>
<tbody>
<tr>
<td>LL</td>
<td>Pattern 1: QUICK DA</td>
<td>0.16</td>
<td>180</td>
<td>Triple low-e glazing: 0.69</td>
<td>18</td>
<td>34.5</td>
<td>10.5</td>
</tr>
<tr>
<td>ML</td>
<td>Pattern 1: QUICK DA</td>
<td>0.19</td>
<td>180</td>
<td>Triple low-e glazing: 0.69</td>
<td>18</td>
<td>30</td>
<td>10.5</td>
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<tr>
<td>UL (flat roof)</td>
<td>Pattern 1: QUICK DA</td>
<td>0.15</td>
<td>180</td>
<td>Triple low-e glazing: 0.69</td>
<td>18</td>
<td>52</td>
<td>10.5</td>
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<tr>
<td>UL (pitch roof)</td>
<td>Pattern 1: QUICK DA</td>
<td>0.08</td>
<td>180</td>
<td>Triple low-e glazing: 0.69</td>
<td>18</td>
<td>24</td>
<td>10.5</td>
</tr>
<tr>
<td>NON</td>
<td>Pattern 1: QUICK DA</td>
<td>0.42</td>
<td>180</td>
<td>Triple low-e glazing: 0.69</td>
<td>10.5</td>
<td>10.5</td>
<td>10.5</td>
</tr>
</tbody>
</table>

**Additional data: LL**

<table>
<thead>
<tr>
<th>Facade including windows</th>
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</thead>
<tbody>
<tr>
<td>Lintel height [ft]</td>
<td>8.8</td>
</tr>
<tr>
<td>Window width [ft]</td>
<td>22.3</td>
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<tr>
<td>Lighting control</td>
<td>Manually</td>
</tr>
<tr>
<td>Motion detector</td>
<td></td>
</tr>
<tr>
<td>Installed lighting power [W/ft²]</td>
<td></td>
</tr>
<tr>
<td>Lighting full load hours [hrs/yr]</td>
<td></td>
</tr>
</tbody>
</table>
# Waynflete School

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Non daylighting kWh</th>
<th>% savings from daylighting</th>
<th>Lighting kWh with daylighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quick daylighting LPD auto (0.91 W/sf)</td>
<td>61547</td>
<td>14%</td>
<td>52654</td>
</tr>
<tr>
<td>Quick daylighting LPD 0.32 W/sf</td>
<td>21353</td>
<td>14%</td>
<td>18268</td>
</tr>
<tr>
<td>Waynflete 201*10, absence 0, LPD 0.32 W/sf</td>
<td>13830</td>
<td>14%</td>
<td>11802</td>
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<tr>
<td>Detailed study</td>
<td>16468</td>
<td>20%</td>
<td>13174</td>
</tr>
</tbody>
</table>
References

• Daylighting Handbook: Fundamentals, designing with the sun – Christoph Reinhart
• ASHRAE Tables 9.5.1 & 9.6.1 – Lighting Power Densities Using the Building & Space by Space Area Methods
• DIN V 18599-10:2007-02, Table 4 – Standard Default Patterns for Internal Loads & Occupancy Calculations for Non-Residential Buildings
• Jan de Boer (Ein einfaches Modell zur Klassifizierung der Tageslichtversorgung von Innenräumen mit vertikalen Fassaden, Fraunhofer-Institut für Bauphysik)
THANK YOU

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