Module 11

Lighting and Small Power

Energy Efficiency for Construction
To equip the learner with the basic knowledge required to understand the energy use of lighting and small power.
Lighting and Small Power | Objectives

- Outline why lighting constitutes significant regulated electrical loads in residential buildings
- Identify current lighting technologies, controls and upgrade opportunities
- Understand the optimal daylight needs of occupants and in buildings
- Outline the energy labelling used for light bulbs and appliances
Topic 1 – Smart Lighting

Topic 2 – Small Power
What is Lighting?

‘Visible light’ is defined by what the human eye can see.
Correlated Colour Temperature (CCT) – warm or cool?

The K-ratio refers to the temperature at which a blackbody radiator would need to be heated to produce a given colour.

**WARM WHITE**
- 2700K
- 3000K
- 3500K
- 4000K

**NEUTRAL WHITE**
- 5000K
- 6000K

**COOL WHITE**
- 7000K
- 8000K

Temperature and feel are two different things:

- A low temperature K (or CCT) rating delivers a warm feel
- A high temperature K (or CCT) rating delivers a cooler, brighter feel

A 2700K lamp will have a warm, glowing feel, as would metal heated to 2700K

A 4100K lamp would be lighter in colour, like metal heated to 4100K

Image Source: BIMzeED
Energy Efficiency for Construction:
Lighting and Small Power

Colour Temperatures – Kelvin Scale

Image Source: Purchased by MosArt – WSETB (Adobe Stock 105150333)
These differences in CCT mean that lamps can be used to create different moods.

- **WARM WHITE (2,500-3,000K)** is widely used in hotels, restaurants, and residential settings.
- **NEUTRAL WHITE (3,000-3,500K)** is preferred for retail and gallery lighting.
- **COOL WHITE (3,500-4,500K)** is often used in schools, offices, industry, etc.
- **COLD WHITE (5,000-7,000K)** is generally limited to special application lighting.
Colour Rendering Index (CRI) is an international system used to rate a lamp’s ability to render eight pastel colours (R1-R8).

Standard CRI measurements do not take into account saturated colours such as the deep red area of the spectrum, key to colour rendering in many aspects of retail display.

So, where appropriate, light sources can also be rated on their ability to render additional colours (or R-values).
Lighting Energy Use

- Lighting and appliances constitutes the **highest proportion of electricity use in residential buildings** (68% on average)

- Lighting and appliances represent **approx. 17% of average household total energy** per year

- **Easy energy use to reduce** (more efficient fittings)
DEAP estimates the amount of daylighting provided in an average dwelling using the following factors:

- Frame factor (% of windows consisting of frame)
- Area of the windows
- Total floor area
- Light transmittance factor
- Light access factor (assumed to be 1.0 for roof lights)
The formula below is used in the Dwelling Energy Assessment Procedure (DEAP) to estimate the annual base lighting requirement in kilo lumen hours.

\[ \Lambda_B = 11.2 \times 59.73 \times (TFA \times N)^{0.4714} \]

Where:
- TFA is the total floor area in m²
- N is the assumed number of occupants
- 11.2 W/lm is the assumed efficacy of traditional tungsten bulbs
- The coefficient and power constants are from SAP 2012

Fixed lighting is assumed to be 2/3 of the total, with portable lighting 1/3.
Heat Gains from Lighting

• Assumed that 85% of annual lighting electricity consumption occurs in the heating season (October to May)
• Assumed that 90% of that energy contributes towards internal gains (the rest for exterior lighting or lighting unheated spaces)
• Formula below is used to calculate heat gains from lighting in DEAP

\[ G_L = E_L \times 0.85 \times 0.9 \times \left( \frac{1000}{24 \times HsDays} \right) \, [W] \]

\( E_L \) is annual electricity used for lighting
\( HsDays \) (heating season days) for Ireland is 243 days
The types of lamps identifiable in DEAP and their associated efficacy values are listed below (the higher the number, the better):

<table>
<thead>
<tr>
<th>Lamp Type</th>
<th>Lumens/Watt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear fluorescent</td>
<td>80.5</td>
</tr>
<tr>
<td>LEDs/ CFL</td>
<td>66.9</td>
</tr>
<tr>
<td>Halogen LV</td>
<td>26.1</td>
</tr>
<tr>
<td>Halogen lamps</td>
<td>15.7</td>
</tr>
<tr>
<td>Incandescent</td>
<td>11.2</td>
</tr>
</tbody>
</table>

Data Source: DEAP Manual Version 4.2 2020
### Lighting Design for House

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Lumens / m²</th>
<th>Typ. Room size</th>
<th>Total lumens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hall, stairs and landing</td>
<td>50 – 100</td>
<td>15m²</td>
<td>1,125</td>
</tr>
<tr>
<td>Living room</td>
<td>100 – 200</td>
<td>15m²</td>
<td>2,250</td>
</tr>
<tr>
<td>Master bedroom</td>
<td>100 – 200</td>
<td>15m²</td>
<td>2,250</td>
</tr>
<tr>
<td>Bedroom 2</td>
<td>100 – 200</td>
<td>12m²</td>
<td>1,800</td>
</tr>
<tr>
<td>Bedroom 3</td>
<td>100 – 200</td>
<td>12m²</td>
<td>1,800</td>
</tr>
<tr>
<td>Kitchen (general)</td>
<td>300 – 400</td>
<td>10m²</td>
<td>3,500</td>
</tr>
<tr>
<td>Utility</td>
<td>300 – 400</td>
<td>4m²</td>
<td>1,500</td>
</tr>
<tr>
<td>Dining room</td>
<td>300 – 400</td>
<td>15m²</td>
<td>5,250</td>
</tr>
<tr>
<td>Kitchen sink or cooker</td>
<td>650 – 750</td>
<td>1m²</td>
<td>700</td>
</tr>
<tr>
<td>Main Bathroom</td>
<td>650 – 750</td>
<td>4m²</td>
<td>2,800</td>
</tr>
<tr>
<td>Downstairs WC</td>
<td>650 – 750</td>
<td>2m²</td>
<td>1,400</td>
</tr>
</tbody>
</table>

**Totals**

- **105m²**
- **25,075**

- Typical light bulb provides 800 lumens
- \(25,075 ÷ 800 = 32 \text{ bulbs}\)
- Average wattage is 10 Watts running for 1,000 hours/yr
- Total electricity use is 32 x 10 Watts x 1,000 hours = 320 kWh/yr
## Energy Efficiency for Construction: Lighting and Small Power

### Image Source: SEAI DEAP

### Energy and carbon emissions with low energy lighting

<table>
<thead>
<tr>
<th>Energy</th>
<th>Carbon Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.18 kWh/m²/yr</td>
<td>5.15 kgCO₂/m²/yr</td>
</tr>
</tbody>
</table>

**Performance**

- **BER**: A2
- **Compliance**:
  - 0.22
  - Target: 0.3
- **0.208**:
  - Target: 0.35
- **0.382**:
  - Target: 0.2
Energy and carbon emissions with incandescent lighting

~ 20% reduction on energy performance by using Incandescent bulbs in place of LED’s

<table>
<thead>
<tr>
<th>Count</th>
<th>Name</th>
<th>Bulb Type</th>
<th>Efficiency [lm/W]</th>
<th>Energy [kWh/m²/yr]</th>
<th>Carbon [kgCO₂/m²/yr]</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>Default Incandescent</td>
<td>Incandescent</td>
<td></td>
<td>33.02</td>
<td>6.49</td>
</tr>
</tbody>
</table>
Services Checks for Lighting

Lighting – checks levels and render EN12464-1
CIBSE guides for compliance

Illuminance-lux, can be measured by devices, known as lux meters. Standards and lighting regulations define light lux levels. To test the regulatory compliance of a lighting installation the illuminance values are measured in several points on the floor. As modelled in lighting software.

Dialux lighting design software
Plan, calculate and visualize light for indoor and outdoor areas. From entire buildings and individual rooms to parking spaces or street lighting.
If you want to Learn More

DIALux Activity

Create your own Dialux project by installing lighting-luminaires using DIALux software:

Download DIALux
https://www.youtube.com/watch?v=NfnaniX0M5E&ab_channel=TheDIALux

With this free software, you can design, calculate and visualize light professionally - single rooms whole floors, buildings and outdoor scenes.

- Select suitable lights for the interior of the building
- Install lights into the model in all the rooms.
- Check compliance with EU regulations defined in the DIALux software

If you prefer to use different lights, then use other catalogues to load into the software.
Energy Efficiency for Construction:
Lighting and Small Power

- LED lamps (low consumption) = energy efficiency classes A+ and A++
- Fluorescent lamps & CFL’s = energy efficiency classes A and B
- Incandescent lamps = category E, (included in the phased-out categories F and G)
- 12V halogen lamps and 230V halogen lamps = energy efficiency class B and C or C and D, respectively.
Energy Efficiency Labels

Product groups are 'rescaled' for EU energy labels:

**Lighting**
**Fridges and freezers**
**Dishwashers**
**Washing machines and washer-dryers**
**Electronic displays including televisions**

“There is no change to the energy efficiency of your current appliance, but it may drop a few letters on the new scale.”

“Something that is currently A+++ may be now be C-rated. That is because the new ratings scale is held to a higher standard, with stricter criteria.”
Reading the lamp label

Your lamp will come with an energy label showing its energy efficiency on a scale from A++ (most efficient) to E (least efficient).

1. The company that made or placed the lamp on the market
2. The lamp model
3. How energy efficient the lamp is
4. Energy consumption during 1,000 hours (typical energy consumption in a year)

A lamp’s package also comes with lots of useful information

1. The energy label (see above)
2. Average lifetime of the lamp (1,000 hours equals an average of one year of usage)
3. Colour of the light, from yellowish (2700K) to daylight (6500K)
4. How accurate the lamp is at revealing different colours (a colour rendering index of 80 is good, 100 is the best)
5. Whether it is dimmable or not (if not, a cross appears over the symbol)
6. How many times the light can be switched on and off before it burns out
7. The more lumens, the brighter the light
Rescaled ENERG Labels

It is estimated that approximately 1500 million light sources were sold in the EU in 2020 – but this figure is likely to fall to 600m in 2030 (i.e. down 60%), even though the number of light sources used will rise by more than 17%. This is because of the greater energy efficiency and in particular the longer lifetime of LED light sources.

A further significant change is the introduction of a QR code on the top right of the new labels. By scanning the QR-code, consumers can find additional information about the product model, such as data relating to the dimensions, specific features or test results depending on the appliance. All appliances on the EU market have to be registered in a new EU-wide database - European Product Registry for Energy Labels (EPREL). This will further facilitate the comparison of similar products in the future.

Source: EC.Europa.eu
Rescaled ENERG Labels

The rescaled labels show more than just the energy efficiency class. For a washing machine, for example, they show at a glance the number of water litres per cycle, the duration of a cycle, and the energy consumption, as measured for a standardised programme.
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Assessment

QUIZ!
Thank You