Module 11

Lighting and Small Power

Energy Efficiency for Construction

24 partners

12 countries

Date of Event

*Author/ **Institute***

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Lighting and Small Power| Summary

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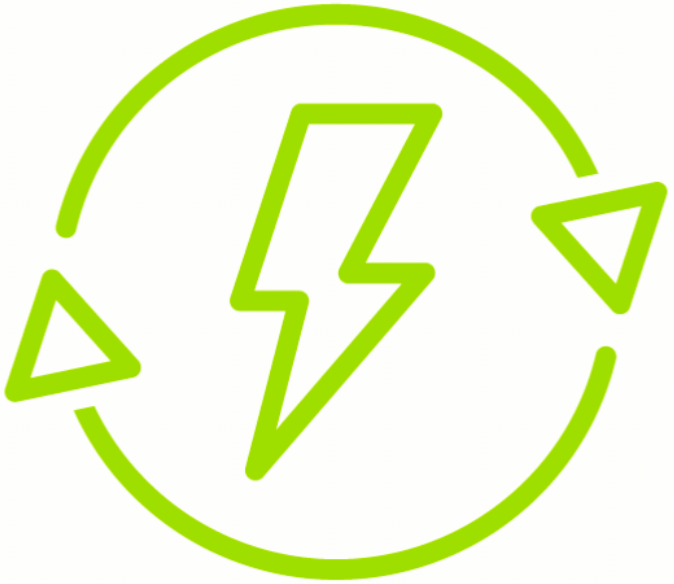
To equip the learner with the basic knowledge required to understand the energy use of lighting and small power



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Lighting and Small Power| Objectives

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- 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

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What is Lighting?

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'Visible light' is defined by what the human eye can see.

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Correlated Colour Temperature (CCT) – warm or cool?

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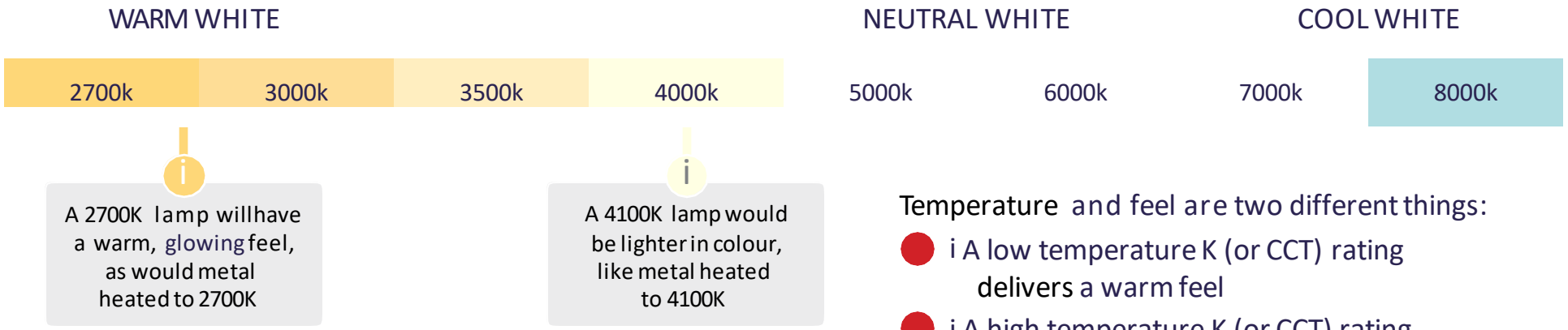
The K -rating refers to the temperature at which a blackbody radiator would need to be heated to produce a given colour.



Temperature and feel are two different things:

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

Image Source: BIMzeED

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Colour Temperatures – Kelvin Scale

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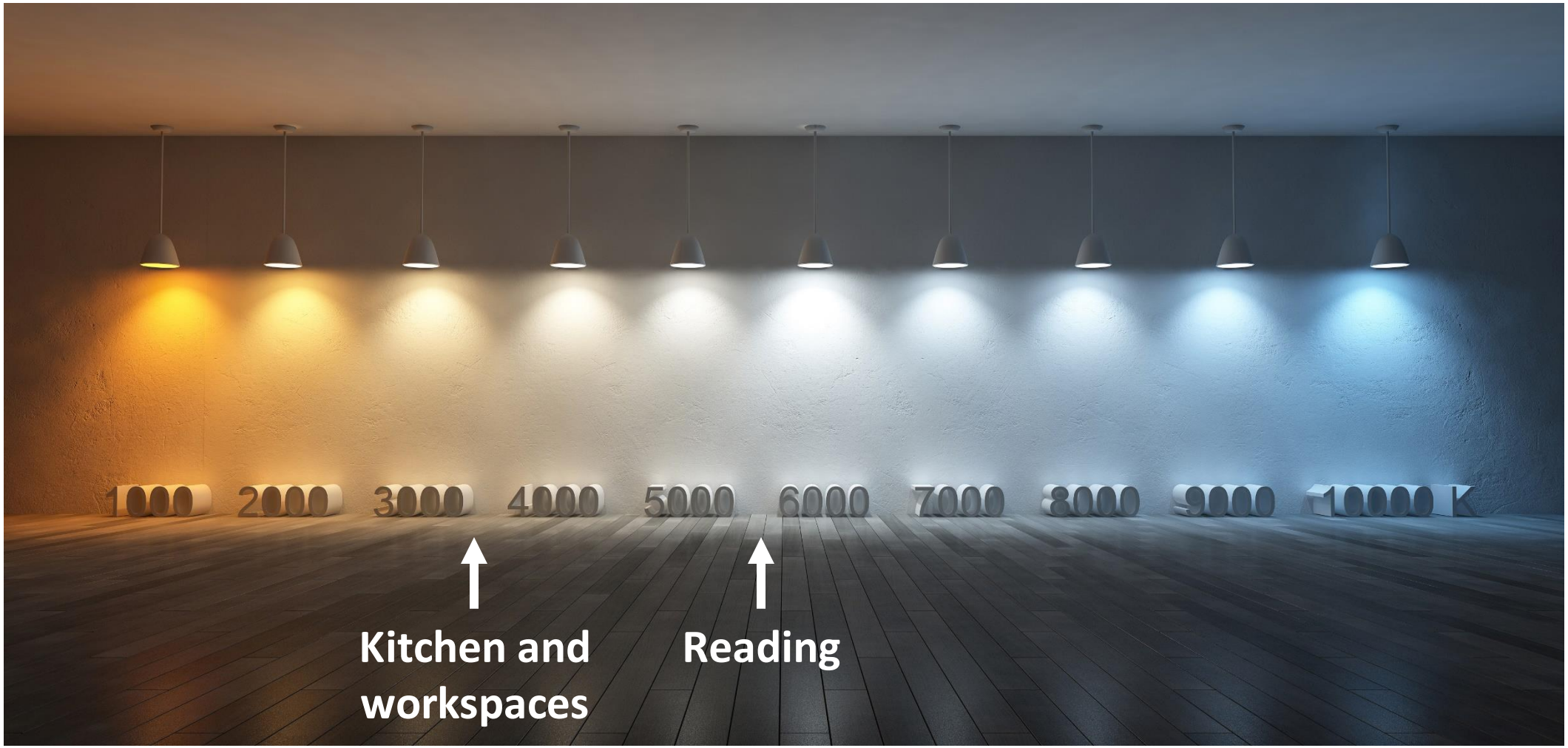

Image Source: Purchased by MosArt – WWETB (Adobe Stock 105150333)

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CCT Applications

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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
- 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

Image Source: BIMzeED

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Colour Rendering Index (CRI)

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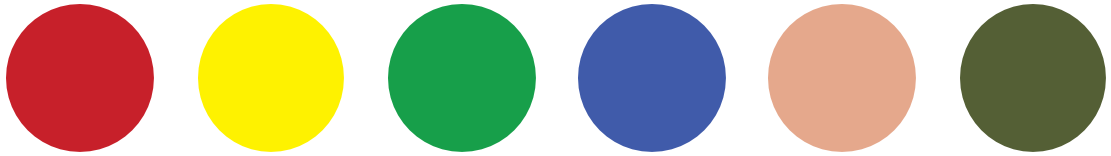
Colour Rendering Index (CRI) is an international system used to rate a lamp's ability to render eight pastel colours (R1-R8).

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.

R9



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

Image Source: BIMzeED

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Lighting Energy Use

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- 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 <u>total</u> energy** per year
- **Easy energy use to reduce** (more efficient fittings)

Figure 6: Residential energy by fuel type, split by end-use, 2016

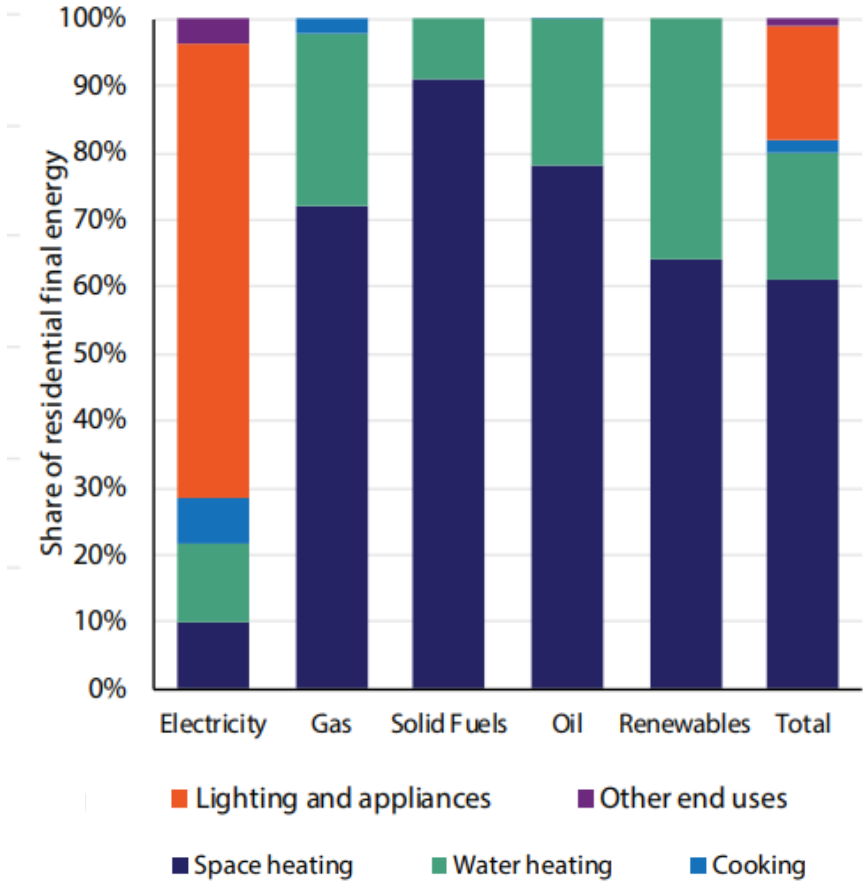

Image Source: SEAI

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Estimation of Daylighting Provision in DEAP

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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)

Table 6b: Transmittance factors for glazing

Type of glazing	Light transmittance (for calculation of lighting requirement)
Single glazed	0.90
Double glazed (air or argon filled)	0.80
Double glazed (Low-E, hard-coat)	0.80
Double glazed (Low-E, soft-coat)	0.80
Window with secondary glazing	0.80
Triple glazed (air or argon filled)	0.70
Triple glazed (Low-E, hard-coat)	0.70
Triple glazed (Low-E, soft-coat)	0.70

Table 6d: Solar and light access factors

Overshading	% of sky blocked by obstacles	Light access factor (for calculation of lighting reqt.)
Heavy	> 80%	0.5
More than average	> 60% - 80%	0.67
Average or unknown	20% - 60%	0.83
Very little	<20%	1

Image Source: DEAP Manual Version 4.2 2020

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Calculation of Annual Base Lighting Requirement in DEAP

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- 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 m^2
- 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 I

- Fixed lighting is assumed to be 2/3^{rds} of the total, with portable lighting 1/3rd.

Image Source: DEAP Manual Version 4.2 2020

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Heat Gains from Lighting

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- 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

$$G_L = E_L \times 0.85 \times 0.9 \times (1000 / (24 \times HsDays)) \text{ [W]}$$

E_L is annual electricity used for lighting
HsDays (heating season days) for Ireland is 243 days

Source: DEAP Manual Version 4.2 2020

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Lamp Types

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The types of lamps identifiable in DEAP and their associated efficacy values are listed below (the higher the number, the better):

Lamp Type	Lumens/Watt
Linear fluorescent	80.5
LEDs/ CFL	66.9
Halogen LV	26.1
Halogen lamps	15.7
Incandescent	11.2

Data Source: DEAP Manual Version 4.2 2020

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Lighting Design for House

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Room Type	Lumens / m²	Typ. Room size	Total lumens
Hall, stairs and landing	50 – 100	15m²	1,125
Living room	100 – 200	15m²	2,250
Master bedroom	100 – 200	15m²	2,250
Bedroom 2	100 – 200	12m²	1,800
Bedroom 3	100 – 200	12m²	1,800
Kitchen (general)	300 – 400	10m²	3,500
Utility	300 – 400	4m²	1,500
Dining room	300 – 400	15m²	5,250
Kitchen sink or cooker	650 – 750	1m²	700
Main Bathroom	650 – 750	4m²	2,800
Downstairs WC	650 – 750	2m²	1,400
Totals		**105m²**	**25,075**

- Typical light bulb provides 800 lumens
- 25,075 ÷ 800 = **32 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**

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Lighting and NZEB Compliance

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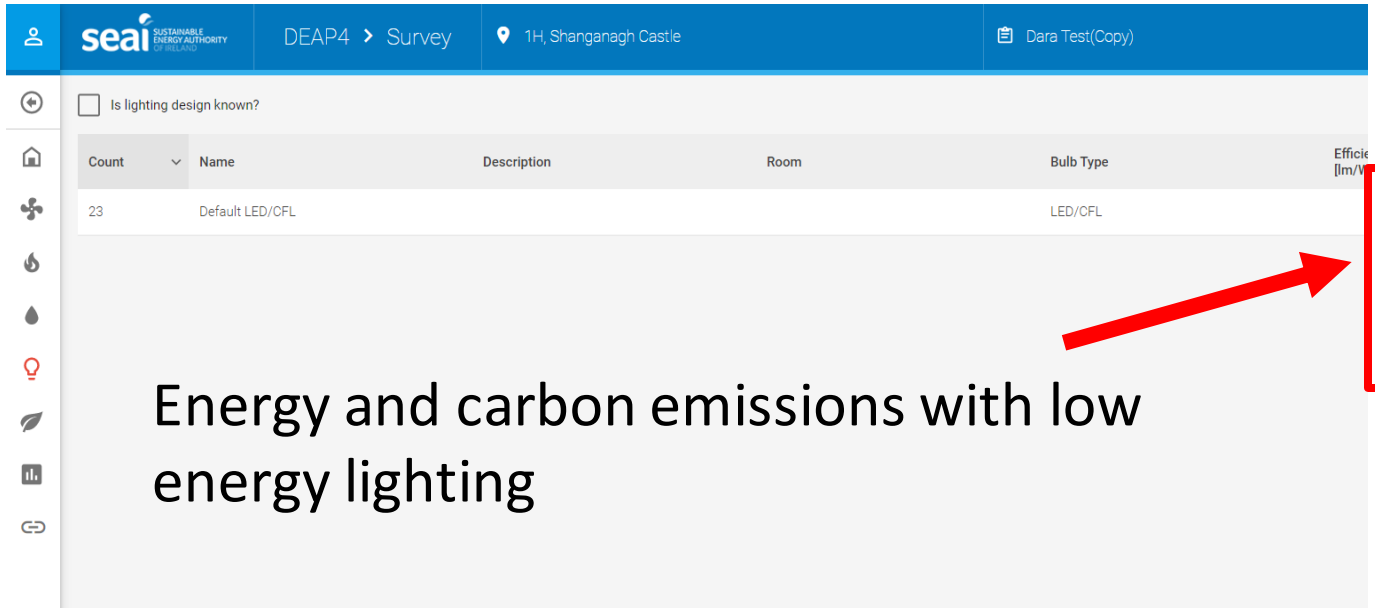

Energy and carbon emissions with low energy lighting

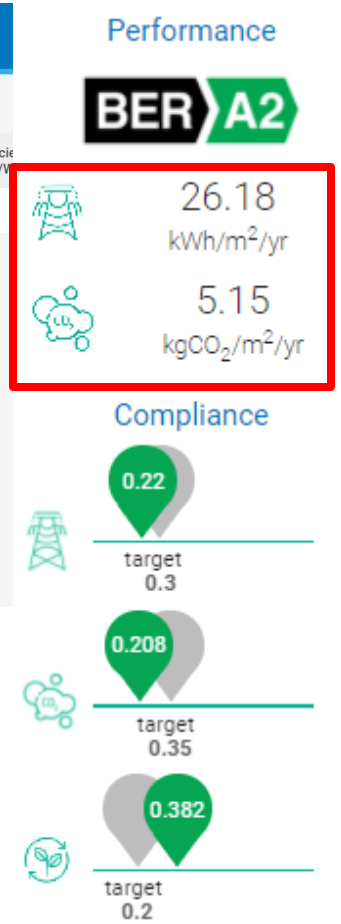

Image Source: SEAI DEAP

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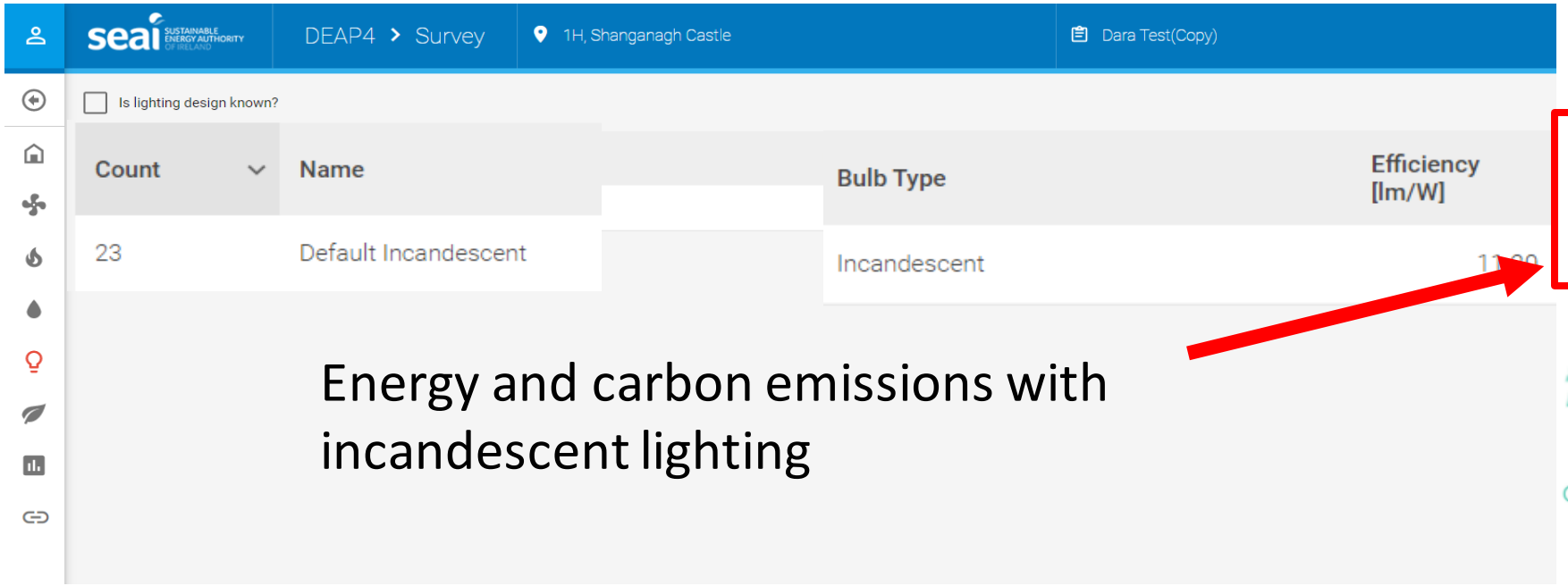

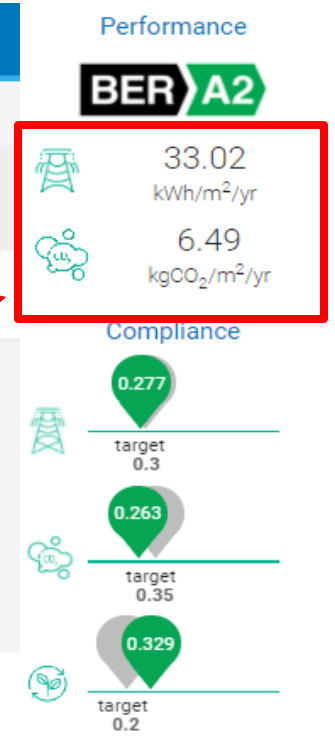

Energy and carbon emissions with incandescent lighting

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

Image Source: SEAI DEAP

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Services Checks for Lighting

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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.

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If you want to Learn More

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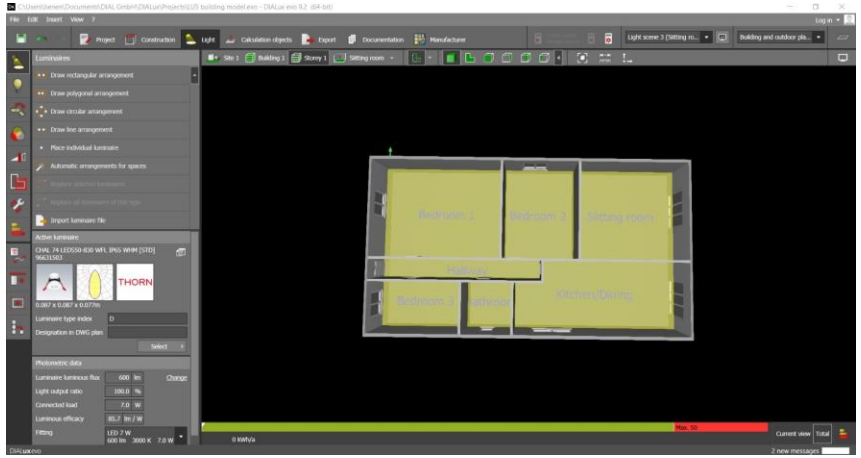
DIAlux Activity

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.

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Energy Labels on Light Bulbs

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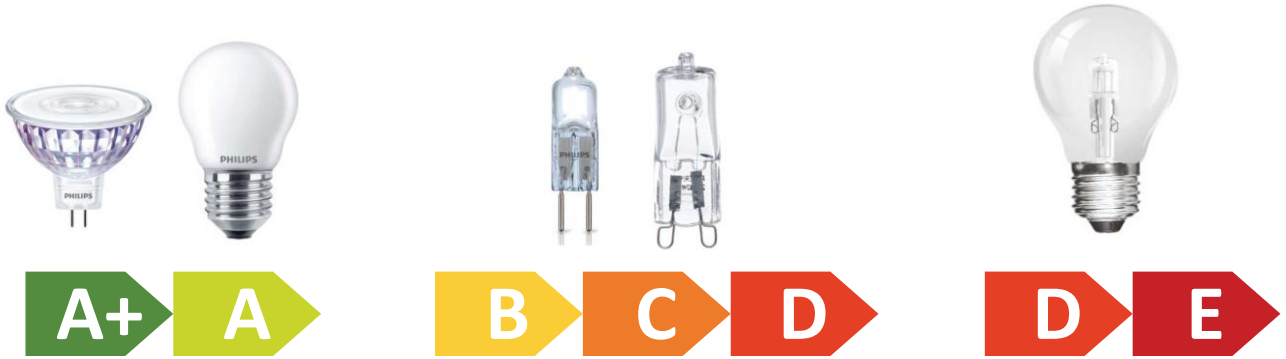
- LED lamps (low consumption) = energy efficiency classes A+ and A ++
- Fluorescent lamps & CFL's = energy efficiency classes A and B
- Incandescent lamps = category E, (included in the phased-out categories F and G)
- 12V halogen lamps and 230V halogen lamps = energy efficiency class B and C or C and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



Energy Efficiency Labels

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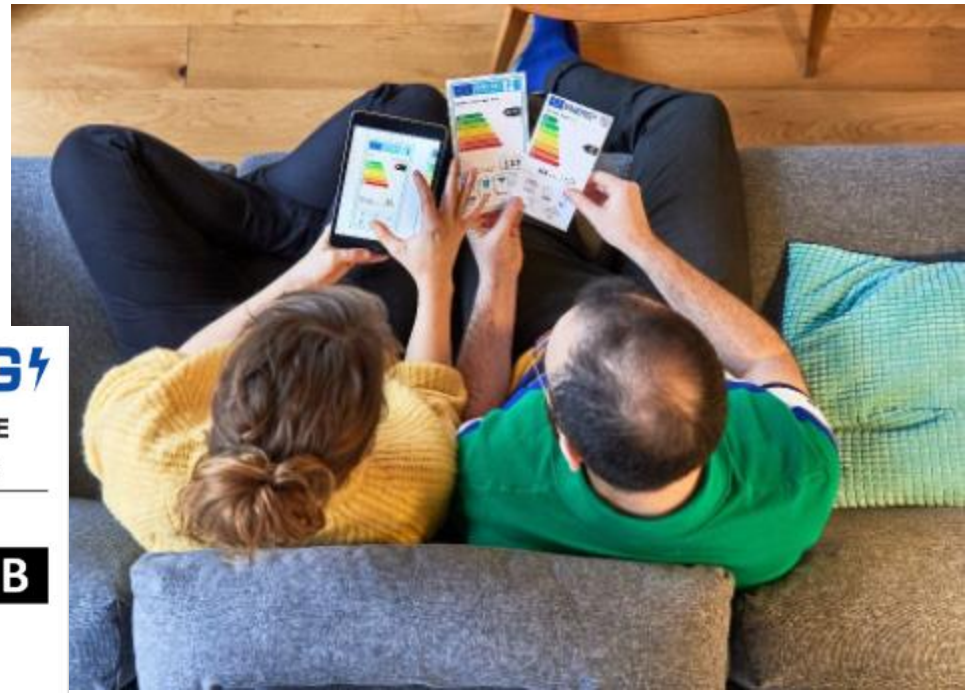
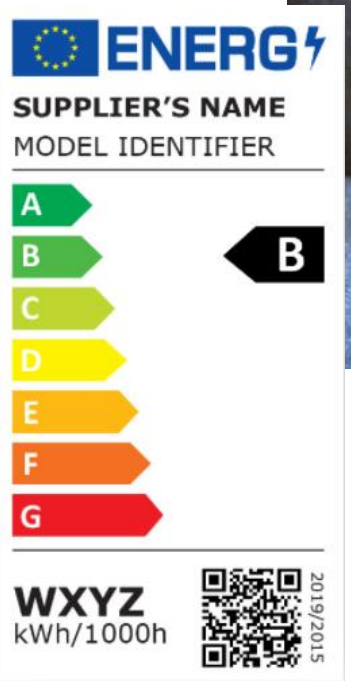
Product groups are 'rescaled' for EU energy labels:

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."

Image Source: Eur-lex.Europa

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Lighting – Energy Efficiency Labels have now changed

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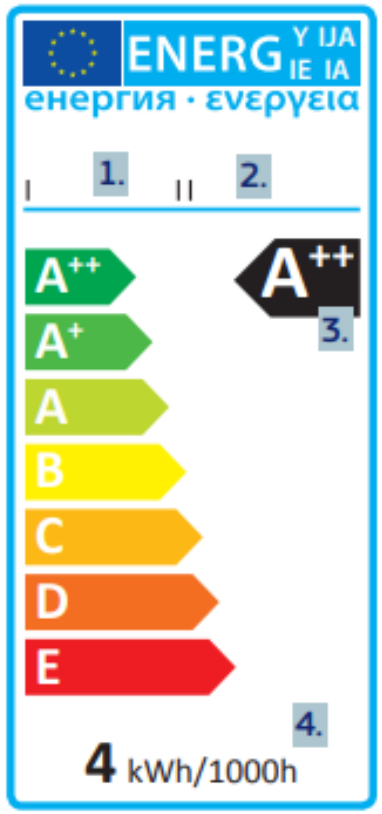
Reading the lamp label

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 (1000 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

Image Source: Eur-lex.Europa

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Rescaled ENERG Labels

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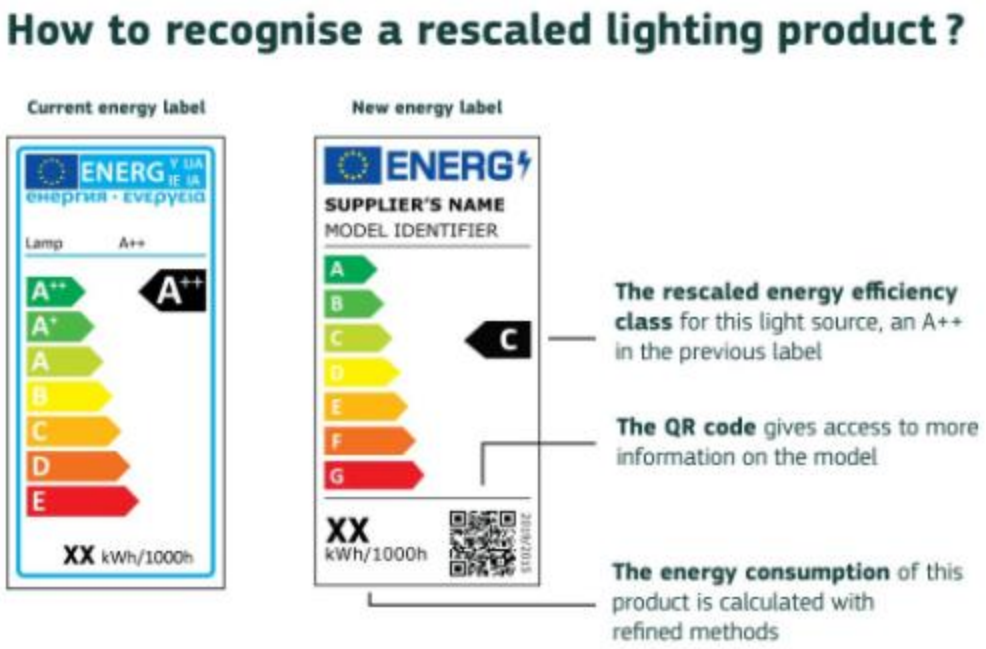
It is estimated that approximately 1500 million light sources were sold in the EU in 2020 – but this figure is likely to fall to 600m in 2030 (i.e. down 60%), even though the number of light sources used will rise by more than 17%. This is because of the greater energy efficiency and in particular the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

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Rescaled ENERG Labels

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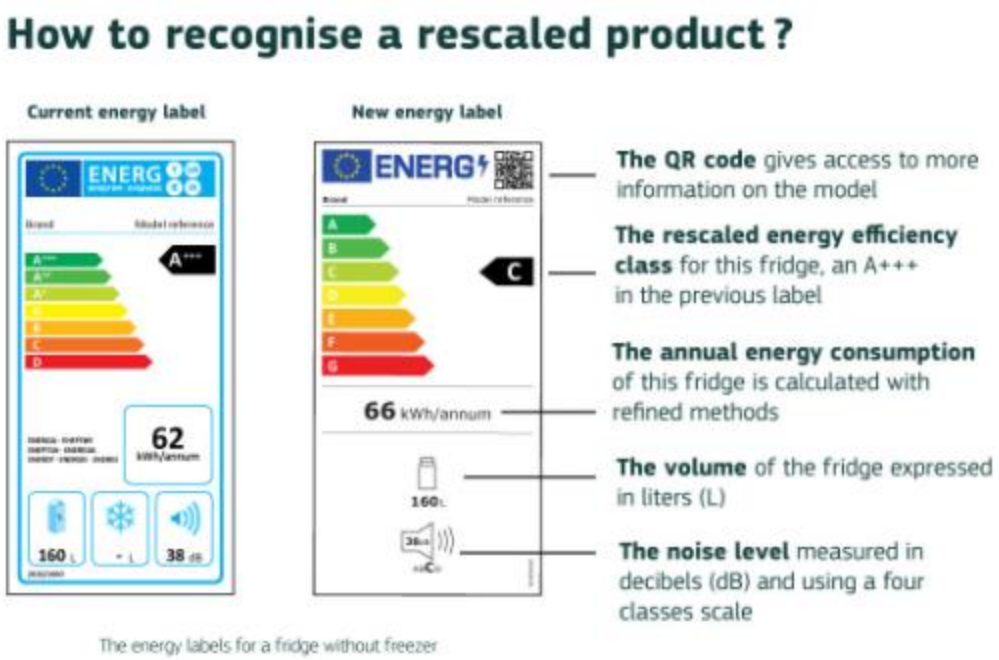
The rescaled labels show more than just the energy efficiency class. For a washing machine, for example, they show at a glance the number of water litres per cycle, the duration of a cycle, and the energy consumption, as measured for a standardised programme.



The energy labels for a fridge without freezer

Source: EC.Europa.eu

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Assessment

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