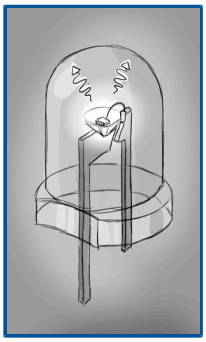
Making light

Up to 40% of the energy used in private houses and offices is spent on lighting. If you know how to generate and use light in a smarter, more efficient way, then you can really make a difference.

Facts to remember

- Light is a form of energy. To generate light, other forms of energy like electricity or heat have to be transformed into light.
- The efficiency of a light source is the ratio of the power of the emitted *visible* light, measured in lumen, and the consumed input power, measured in Watt (shown on light sources as lm/W).
- Light is emitted in small, discrete energy packages or quanta, which are called photons.
  The energy (E) of a photon solely depends on the frequency (ν) of light:
  $E = h \nu$
  In this equation, h stands for the Planck constant h = 4.135 ×10^{-15} eVs,
  named after Max Planck who discovered the quantization of light energy and thus the photon.
- A photon with a higher frequency (e.g. blue) has a higher energy than a photon with a lower frequency (e.g. red).
- Electric light can be switched off. This saves energy, money, and, to some extent, our planet.

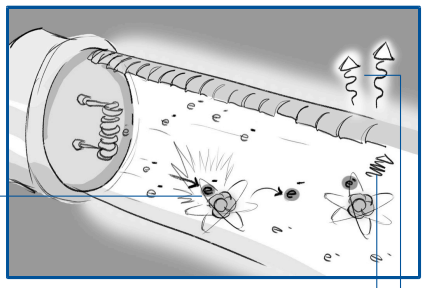
Light emitting diodes (LEDs)



As you probably noticed, the spectra of LED's differ from that of incandescent light sources. While the spectra of incandescent light sources are continuous from infrared up to a wavelength that depends on the filament's temperature, the spectra of LED's only cover a certain range of wavelengths. The reason is that LED's generate light not by heat but by electrons that emit light when dropping into a lower energy state.

In a LED, the light originates from the interface of two slightly different materials. One has a surplus of free electrons (not bound to an atom), while the other has a lack of electrons (atoms missing an electron to be uncharged). When the electric current flows in the right direction, the free electrons drop down from their higher energy level and recombine with the atoms in the other material while emitting their energy as a photon. The difference between the two energy levels determines the photon's frequency and thus the colour of the light.

Fluorescent light tubes



Up to now, fluorescent light tubes are the most efficient light sources for white light – even though the energy is transformed several times before visible light is generated: In a gas-discharge, an electric field between the two ends of the tube accelerates free electrons. If these electrons crash into one of the mercury atoms in the tube, their kinetic energy can be enough to kick out one of the electrons of this atom. The freed up space is soon filled by another (or the same) electron, and the energy freed by this recombination is radiated as a photon.

However, the energy of these photons and thus the frequency of the light are too high to be visible for the human eye. In fact, the generated ultraviolet light can even be dangerous for our eyes. The wall of the tube is therefore covered by a special powder with a mixture of phosphors that absorbs the ultraviolet light. The ultraviolet photons excite electrons of the phosphors into a higher energetic state. Depending on the type of phosphor, these excited electrons fall back into their normal energetic state in two or three smaller steps. At some of these steps, photons are emitted at a visible wavelength. The mixture of phosphors determines the colour of the light tube.