

Cost of Energy

How much does it cost to operate a light bulb for a year? Does your electricity bill for the year cover the full cost, or are you somehow being subsidized without knowing it? In this project you will make a simple analysis of the true cost, assuming that the electricity powering your light bulb was generated by burning coal.

Units and dimensions facts: Energy and power are related by the equation

$$\text{Energy} = \text{Power} \times \text{Time}.$$

Units of energy: Joule (J), Watt-hour (Wh) , kilowatt-hour (kWh)

Units of power: Watt (W), kiloWatt (kW)

Conversion factor: 1 Watt = 1 Joule/second.

1. Energy production

Burning 1 kilogram of coal generates about 3×10^7 Joule of energy. In a power plant, approximately 35% of this energy can be captured and converted to electrical energy. About 10% of the electrical energy is lost during transmission through the power grid to your home. You have a 60 Watt light bulb, which wastes 98% of the energy it receives in heat, converting just 2% into light.

If the light bulb burns 8 hours a day for a year

- (a) How much light energy is emitted?
 - (b) How much coal is burned?
 - (c) What fraction of the coal energy is converted to light? (This fraction is called the energy efficiency of the system for powering the light bulb.)
2. Find the cost of the energy used to power the light bulb during a year due to the following factors.
- (a) Generating and delivering the energy, at 10¢ per kilowatt-hour that reaches your home. (This is the amount you pay.)
 - (b) Air pollution, at 9.31¢ per kilowatt-hour of electrical energy generated at the power plant.
 - (c) Public health harm, at 4.69¢ per kilowatt-hour of electrical energy generated at the power plant.
 - (d) Climate damage at 3.15¢ per kilowatt-hour of electrical energy generated at the power plant.
3. How much would you have to pay if your bill covered pollution, health, and climate damage costs as well as electrical energy?

4. Your electricity bills do not cover the costs of air pollution, public health harm, and climate damage caused by burning the coal to light your house. Who pays those costs? Who should pay them? How should they be paid for?
5. Find resources on the internet that enable you to make a similar calculation using solar energy power rather than coal. How many square meters of solar cells are required to burn a 60 Watt light bulb for a year? What are the costs? Which do you think is a better source of power, coal or solar energy, and why?

References

- [1] http://www.mpoweruk.com/energy_efficiency.htm#comparison
- [2] <http://www.groundtruthtrekking.org/Issues/AlaskaCoal/CoalTrueCost.html>
- [3] http://solar.gwu.edu/index_files/Resources_files/epstein_full%20cost%20of%20coal.pdf