

ENERGY, POWER, ELECTRICITY

Main themes

- Power and energy
- Energy consumption quantification
- Electricity

Energy and electricity

- **Non-electrical energy**
 - Road transport
 - Rail transport
 - Heating
 - Hot water
 - Cooking
 - Sea transport
 - Aviation
- **Electrical energy**
 - Grid
 - Rail transport



Power (W)

The rate at which work is done

Rate at which energy is consumed by an appliance

Rate at which energy is produced by generator

The unit of power is the watt (W)

Usually written on the labels of appliances

1000 watts is a kilowatt (kW)

kW_e

kW_t

Energy (Wh)

- Energy is amount of work (over time) done
- Amount of energy consumed by an appliance
- Amount of energy produced by generator
- The unit of energy is the watt-hour (Wh)
- 1000 watt-hours is a kilowatt-hour (kWh)

kWh_e

kWh_t

Basic energy calculation

$1 \times 80 \text{ W light bulb} \times 2 \text{ hours} = 160 \text{ Wh}$

$2 \times 80 \text{ W light bulb} \times 1 \text{ hours} = 160 \text{ Wh}$

$3 \times 80 \text{ W light bulb} \times 6 \text{ hours} = 1,440 \text{ Wh}$

$3 \times 80 \text{ W light bulb} \times 6 \text{ hours} = 1.44 \text{ kWh}$

Energy consumption - lights

Low energy light bulb

$18 \text{ W} \times 4 \text{ h} = 72 \text{ Wh}$



Incandescent

$80 \text{ W} \times 4 \text{ h} = 320 \text{ Wh}$



LED (less light)

$4 \text{ W} \times 4 \text{ h} = 16 \text{ Wh}$



Energy consumption - computers

Laptop computer

$30 \text{ W} \times 4 \text{ h} = 120 \text{ Wh}$



Flat screen computer (small)

$100 \text{ W} \times 4 \text{ h} = 400 \text{ Wh}$



Desktop computer (cathode)

$200 \text{ W} \times 4 \text{ h} = 800 \text{ Wh}$

(90 W to 300 W)



Use of **large** plasma screens consumes a lot of energy

Energy consumption - fridges

Fridge

$$80 \text{ W} \times 8 \text{ h} = 640 \text{ Wh / day}$$

or

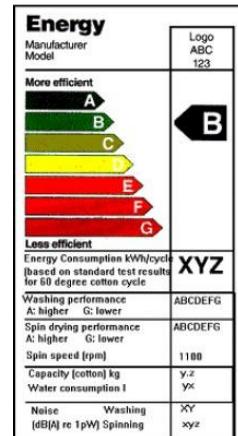
LABEL:

$$234 \text{ kWh / year}$$

divided by 365

$$= 640 \text{ Wh / day}$$

Large low energy fridge (A)
can consume more energy
than small less efficient (B)



Energy consumption – shower, heater

Shower

$8000 \text{ W} \times 0.08 \text{ h} = 640 \text{ Wh}$

(5 minutes)

Immersion heater

$2000 \text{ W} \times 0.5 \text{ h} = 1,000 \text{ Wh}$

(30 minutes)

Electric bar heater

$2,000 \text{ W} \times 4 \text{ h} = 8,000 \text{ Wh}$

Cooling

Fan

$30 \text{ W} \times 6 \text{ h} = 180 \text{ Wh}$

Air conditioning unit
(wall mounted)
 $2,000 \text{ W} \times 6 \text{ h} = 12,000 \text{ Wh}$

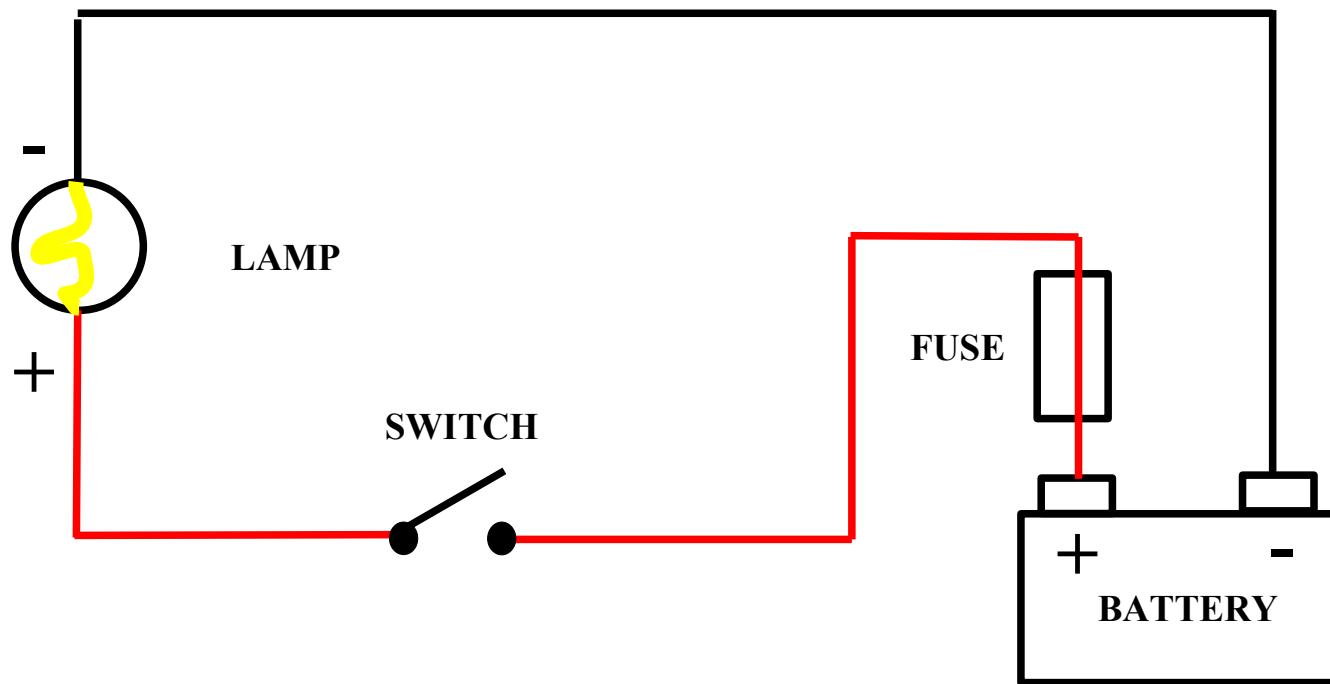


30 W

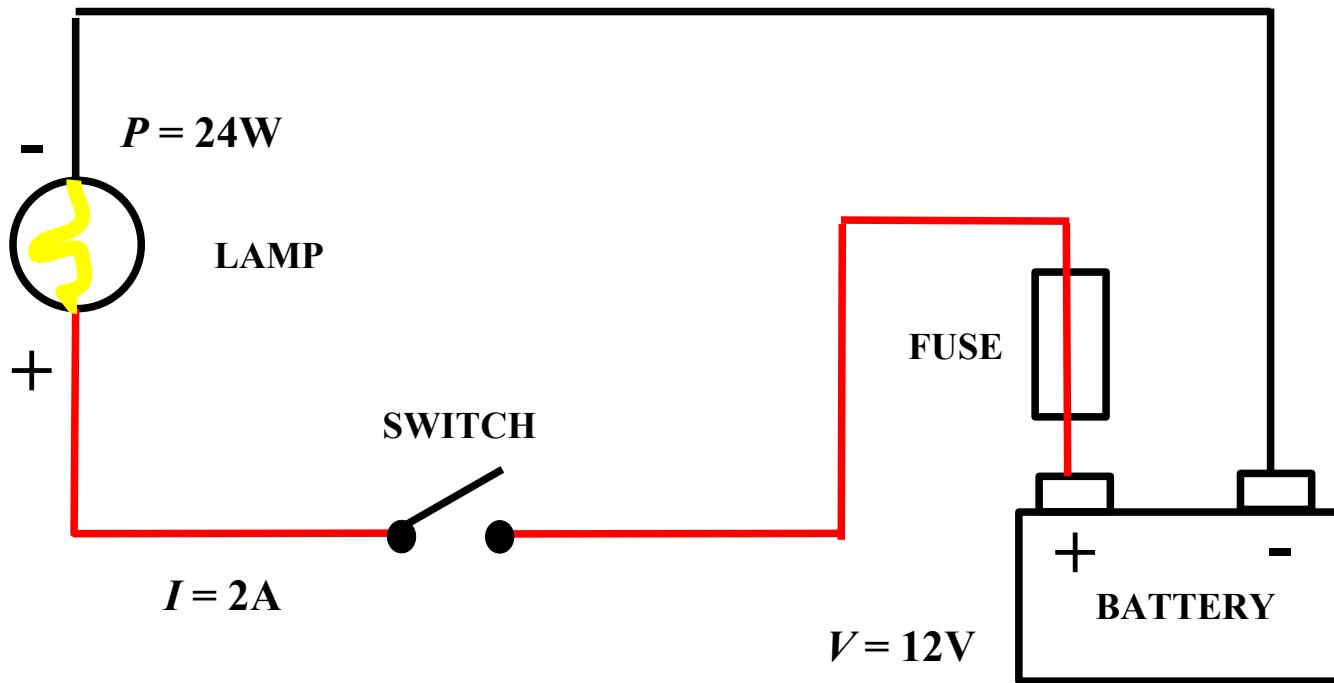
Daily electrical energy use calculation

Appliance	Quantity	Wattage	Hours on	Wh/day
Low energy lights	2	13	4	104
Low energy lights	2	18	4	144
Laptop	1	30	7	210
Music system	1	30	3	90
Fridge		400 kWh /365 days		1095
			TOTAL (Wh/day)	1643

Electricity – basic circuit



$$P = V I \quad V = \frac{P}{I} \quad I = \frac{P}{V}$$



Voltage [V] is measured in units of volts [V]

Current [I] is measured in units of amps [A]

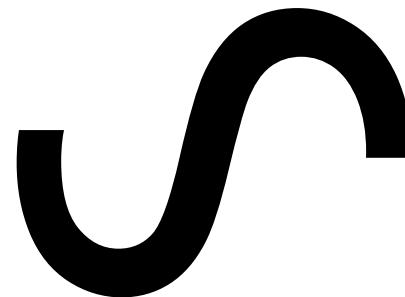
Power [P] is measured in units of watts [W]

Electricity – DC & AC



Direct Current

- Batteries
- Solar modules
- Small wind generators



Alternating current

- The grid
- Generators
- Inverters

Inverter

