Poster calculations

The facts that are incorporated in the Carbon Trust's poster campaigns are shown below along with how they have been calculated for reference.

Calculations for CO2 from kWh gas and electricity use Defra’s 2005 conversion factors.
Posters are available to download at http://www.carbontrust.com/awareness

PFL306
Employee awareness poster - Lighting

Assumption
"Office lights left on overnight use enough energy in a year to heat a home for almost 5 months."

Calculation
This fact is based on a typical small office space of 100m$^2$ with 18 x 6ft (1800mm) T8 tubes at 70W each. Assuming lights are left on when the building is unoccupied for 14 hours (6pm-8am).

\[
14(\text{hours}) \times 70(\text{Watts}) / 1000 \times 18(\text{tubes}) \times 365(\text{days}) = 6438.6\text{kWh}.
\]

Annual heating for a typical 3 bed semi-detached is 16,308kWh (Source: http://www.north-dorset.gov.uk).

Based on these calculations you would be able to heat a 3 bedroom semi-detached home for 4 months and 22 days.

\[
16,308\text{kWh} / 12(\text{months}) = 1359\text{kWh per month} / 31(\text{days}) = 43.84\text{kWh per day}.
\]

\[
6438.6\text{kWh} / 43.84\text{kWh} = 146.9 \text{ days (4 months and 22 full days)}.
\]

PFL307
Employee awareness poster – Heating

Assumption
"A 2°C increase in office temperature creates enough CO2 in a year to fill a hot air balloon."

Calculation
This fact is based on a typical office space of 1500m$^2$ heated to 20°C using 226,500kWh gas for heating and hot water (Source: Carbon Trust - ECG019 - Energy use in offices). Assuming 75% energy is used for heating.

\[
226,500\text{kWh} \times 0.75(\text{percent}) = 169,875\text{kWh}.
\]

Assuming outside temperature is 7°C during the heating season.

\[
22°C(\text{office temperature}) - 7°C(\text{outside temperature}) / 20°C(\text{office temperature}) - 7°C(\text{outside temperature}) = 0.1538 (15.38\% \text{ difference})
\]

\[
15.38\% \times 169,875\text{kWh} = 26,134.62\text{kWh}.
\]

\[
26,134.62\text{kWh} \times 0.191\text{kWh/kgCO2} (\text{conversion factor for gas to weight in CO2}) = 4991.711538\text{kgCO2} / 1.98
\]
(conversion factor for CO$_2$ weight to volume) = 2521.07 m$^3$ CO$_2$.

Average hot air balloon volume is 2500 m$^3$ (Source: http://en.wikipedia.org).

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**PFL308**

**Employee awareness poster - Refrigeration**

**Assumption**

"A chiller door left open for 30 minutes a day wastes enough energy in a year to power a lighthouse for nearly 4 days."

**Calculation**

Assuming chiller is 5 m$^3$ single door refrigerated display cabinet. Standard power use is 0.2kWh (Source: http://www.eca.gov.uk).

0.2kW x 0.5(hour) x 365(days) = 36.5kWh.

Lighthouse 0.4kW x 24(hours) x 4(days) = 38.4kWh (Source: http://homepages.manx.net/fredd/autolight.html).

Based on these calculations you would be able to power the lighthouse for 3 days, 19.25 hours.

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**PFL309**

**Employee awareness poster – Computer**

**Assumption**

"Leaving a computer on overnight for a year creates enough CO2 to fill a double-decker bus."

**Calculation**

Assuming computer is energystar category 'A' and monitor is flatscreen 1280 pixels by 1024 pixels, and power rating is 0.107kW when active. Assuming computer is left on when the building is unoccupied for 14 hours (6pm-8am).

0.107kW x 14(hours) = 1.498kWh x 365(days) x 0.43kgCO$_2$/kWh = 235.111kgCO$_2$/year.

235.111 / 1.98 (conversion factor for CO$_2$ weight to volume) = 118.74 m$^3$ CO$_2$/year.

Estimated volume of double decker bus = 102.12 m$^3$.

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**PFL310**

**Employee awareness poster – Photocopier**

**Assumption**

"A photocopier left on standby overnight wastes enough energy to make 30 cups of tea."

**Calculation**

Assuming a photocopier on standby uses 0.042kW, and is left on when the building is unoccupied for 14 hours (6pm-8am). Assuming cup of tea is 0.25 litres.

0.042kW x 14 hours = 0.588kWh.

Average cup of tea = 0.25 litres = 0.25kg.
Energy used to make cup of tea = 0.25kg x heat capacity of water (4200J/kg/°C) x temperature rise (90°C - 20°C) = 73,500 joules = 0.02kWh.

0.588kWh/0.02kWh = 29.4 cups of tea.

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**PFL311**

Employee awareness poster - Air conditioning

**Assumption**

"Air conditioning an office for 1 extra hour a day uses enough energy in a month to power a TV for over a year."

**Calculation**

Assuming typical office floor area = 1500m$^2$. Average air conditioning system uses 0.03kW/m$^2$ ([Source: http://www.cribe.uk.com](http://www.cribe.uk.com)). Assuming 32" widescreen LCD TV using 0.14kW.

$0.03\text{kW/m}^2 \times 1500\text{m}^2 \times 1(\text{extra hour}) \times 31(\text{days}) = 1395\text{kWh}.$

Television energy use $0.14\text{kW} \times 24(\text{hours}) \times 365(\text{days}) = 1226.4\text{kWh}.$

Based on this calculation you would be able to power television for 1 year, one month, and 19 days.

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**PFL312**

Employee awareness poster - Compressed air

**Assumption**

The energy wasted from a compressed air leak the size of a match head is responsible for yearly CO$_2$ emissions equal to the weight of an elephant.

**Calculation**

Based on a typical 110kW compressor running 24/7 producing 18m$^3$/minute = 635ft$^3$/minute (18 x 35.3147 - conversion from cubic metres to cubic feet) at 7.5BAR (108psi). Match head is 1.6mm. Air lost through 1.6mm hole is 6.49cfm.

$6.49/635.7 = 0.0102$ proportion of compressor power needed to replace air lost.

$110\text{kWh} \times 0.0102 = 1.12\text{kWh} \times 24(\text{hours}) \times 365(\text{days}) = 9838.15\text{kWh}.$

$9838.15\text{kWh} \times 0.43\text{kgCO}_2/\text{kWh}$ (conversion factor for kWh to CO$_2$ weight) = $4230.40\text{kgCO}_2$.

An Asian Elephant weighs between 3000 and 5000kg ([Source: http://www.wikipedia.org](http://www.wikipedia.org)).

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**Energy efficiency poster calculations**

1) "A photocopier left on overnight uses enough energy to produce over 1500 copies"

This fact is based on a mid-volume copier. In "sleep" mode this uses 51W and is on all day. Assume that the office is empty from 6pm to 8am = 14 hours.

Then (51W x 14 hours) / 1000 = 0.714kWh.

In copy mode the machine uses 614W and produces 25 copies a minute (1/60=0.016667 hours).
This is \((614 \times 0.016667) / 1000 = 0.010233\) kWh for 25 copies
\[0.714\text{kWh} / 0.010233 = 69.77199\]
\[69.7719 \times 25(\text{copies}) = 1,744\text{ copies could be produced overnight.}\]

2) "Lighting an office overnight wastes enough energy to heat water for 1000 cups of tea"

This fact is based on a typical office space with 18 x 6ft (1800mm) T8 tubes at 70W each. Ballast increases consumption by 25% so consumption is 87.5W each. Assuming lights are left on when the building is unoccupied for 14 hours (6pm-8am)
\[(14(\text{hours}) \times 87.5(\text{Watts})) / 1000 \times 18(\text{tubes}) = 22.05kWh\]
Assume 1 cup of tea requires raising the temperature of 0.25 litres (i.e. 0.25kg) through 70°C (from 20°C to 90°C approx).
Specific heat capacity = 4200 J/kg/°C
Energy requirement = 4200 x 0.25 x 70 = 73,500 J
Conversion to kWh = 73,500 / 3,600,000 = .02 kWh
Based on these calculations, then these lights use enough energy to make 1103 cups of tea.

3) "A typical window left open overnight in winter will waste enough energy to drive a small car over 35 miles"

Assumes vehicle performance of 10 miles/litre ( = 45mpg). Calorific value of petrol = 32 MJ/litre (Dukes 2002) = 8.9kWh i.e. 1.12 miles/kWh
Assume the effect of the open window is air movement at an average velocity equivalent to 0.1 m/s perpendicular to the facade across its cross sectional area.

For a window with an openable area of 1 sq.m this is equivalent to an air change rate of 0.1 cu.m/s, = 360 cu.m/hr.
density of air = 1kg/cu.m, heat capacity = 1200 J/kg/°C, so for outside air at 0°C displacing internal air at an average temperature of 16°C.
Heat loss per hour = 360 X 1 X 1200 X 16 = 6,912,000 J = 1.92 kWh.
Assume window remains open for 14 hours, 27kWh
Assuming a boiler efficiency of 80% gas fuel requirement is 27/.8 = 33.75 kWh
1.12 * 33.75 = 37.8 miles

4) "A PC monitor switched off overnight saves enough energy to microwave six dinners"

Assumes stand-by consumption of monitor is 20W Monitor in use for 8 hours and in stand-by overnight for 16 hours. Energy wasted by monitor is 20W x (16 hours x 60 sec x 60 mins) = 1,152,000 J
Assumes microwave meal is heated for 4 mins in an 800W microwave
800W x (4 mins x 60 sec) = 192,000 J
Number of meals = 1,152,000/192,000 = 6.

5) "Switching off all non essential equipment in an office for one night will save enough energy to run a small car for 100 miles."

(Or uses enough energy to photocopy 224,000 copies or would make over 4500 cups of tea.)
Overnight is from 5pm to 9am - 16 hours
Assume no power save is enabled on the PC's or monitors and 18 6ft fluorescent lights at 70W with wire bound ballasts.
For lights – 18 (T8) lights x (70W + 25%) x 16 hours = 25kWh
Switching off 1 photocopier 51W standby consumption x 16 hours = 0.8kWh
Switching off 30 PC's (140W each) = 25 x 140W x 16 hours = 67.2kWh
Switching off 1 laser printer 45W standby consumption x 16 hours = 0.7kWh
Assumes vehicle performance at 10 miles/litre (=45mpg). Calorific value of petrol = 32MJ/litre (Dukes 2002) = 8.9kWh i.e. 1.12 miles/kWh
25+0.8+67.2+0.7=93.7kWh overnight x1.12 miles = 105 miles
6) "A compressed air leak the size of a match head wastes enough energy in a working day to toast 444 slices of bread"

It takes 2 mins and 15 secs to toast 2 slices of bread in a 950W toaster (empirical data).
Energy used to toast 2 slices of bread = (2.25 minutes) / 60 minutes * 950W = 36Wh
Or 36Wh / (2x1000) = 0.018kWh per slice of toast.
A 1.6mm (match head) hole in a compressed air system wastes 1kW of electricity (Source: Good Practice Guide 126).

The energy wasted for a 1.6mm leak during an 8 hour working day is 1kWx8 hours = 8kWh.
The number of slices of bread that could be toasted with this energy is
(8kWh) / 0.018kWh = 444 slices of toast.