# Wasted electricity in Mobile Phone Chargers

*NOTE: This is model resource only. The calculations and example question shown are not complete.*

**Title:** Estimating wasted electricity in mobile phone chargers.

**Background:** The accompanying resource on "Domestic Energy Use and Sustainability[1]" introduces the concept of power wastage of electrical devices. In this mockup question, a calculation to determine a generic efficiency for these units is modified to include lessons in Engineering for Sustainable Development using Transferable Skills. This is achieved by relating the generic convertor and its engineering performance metrics to a physical real-world device that students can relate to. The original engineering question remains intact.

**Overview and motivation for this exercise:** This example question asks the student to consider a generic low-voltage AC-DC convertor and put it into a real-world context. They are then asked to estimate the overall energy wasted globally if this device were the standard for all mobile phones. In finding an answer they will have to practice several transferable skills including estimation and analysis with uncertainty. The final answer will help to raise their awareness of ESD issues in electrical engineering, especially the fact that production of even a very small device can have a huge impact if it is mass-produced in quantity.

**General and Specific Resources:** The ImpEE resource on the Domestic Energy Use and Sustainability[1] discusses the concept of standby power wastage, or "Vampire Power". Real-world figures for wasted power in an assortment of domestic electrical items can be used to reinforce the relevance of this analysis.

In developing the concepts of Engineering for Sustainable Development, this resource makes reference to the figure titled "Engineering Choices[2]" reproduced below as Figure 1 and freely available for download from the provided link.

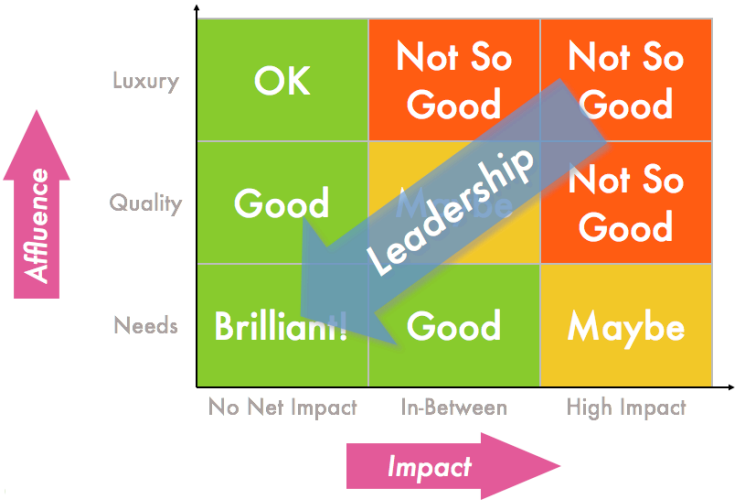


**Figure 1:** "Engineering Choices[2]" from the ImpEE resource on "Introduction to ESD".

**Links:**

1. "Domestic Energy Use and Sustainability", ImpEE Resource, http://www-g.eng.cam.ac.uk/impee/?section=topics&topic=DomesticEnergy
2. Engineering Choices figure from the ImpEE "Introduction to ESD" http://www-g.eng.cam.ac.uk/impee/topics/IntroToESD/files/Engineering%20Choices.png

Addition leaves original question intact

**Example Question:**

Consider a switching mode power supply. Work out what the supply side voltage would be for the configuration shown. Under maximum load, what power would the transformer dissipate in worst case? What would the efficiency be in that case? Estimate the annual cost of the wasted electricity if all the mobile phones in the world used similar chargers.

If mobile phones are left charging each night, all night, and the charger remains plugged into the mains and switched on, what difference does this make to energy wastage? What would be the difference if the device automatically shut off when the battery is charged?

You are going to be interviewed by the local radio and will be asked to explain to the listeners how much energy is wasted by mobile phone chargers. How will you explain the problem in a way that convinces listeners about the magnitude of the problem and to take action in reducing energy demand?

By giving a real-world example the generic question is given engineering context

**Figure 2:** A typical mobile phone charger.

**Example Solution:**

(for the purposes of the mock-up question let us assume that the charger efficiency is calculated to be 40%)

In estimating the annual cost of the wasted electricity if all the mobile phones in the world used similar chargers several assumptions need to be made:

Assuming:

2.1.3. Estimation and Qualitative Analysis
2.1.4. Analysis With Uncertainty
2.2.2. Survey of Print and Electronic Literature

- the number of global mobile phone users is ≈ $1.5 \times 10^9$
- we charge our phones every 3 days, so ≈ 120 times per year
- average mobile phone battery is 700mAh at 3.7V so ≈ 2.5Wh
- in UK power costs 10p/kWhw

NOTE: This analysis assumes the charger is turned off as soon as the phone is completely charged. This is not always the case which could add a factor of 3 or more.

Awareness of ESD Issues

4.1.2. The Impact of Engineering on Society

Then the total annual global cost of wasted electricity would be around **£45 million**.

## Transferable Skills: *(The numbers after each transferable skill refer to the CDIO Syllabus available on-line at http://www.cdio.org )*

**Estimation and qualitative analysis (2.1.3)/Analysis with Uncertainty (2.1.4)** In this calculation, the students are expected to make estimations to come up with approximate answers. Although this is reflective of the real world, it is quite different from what is done in the standard curriculum so many students feel uncomfortable. The lecturer should stress to the students that the objective of the question is to qualify a relative feel for the amount of electricity that would be wasted, not to get an exact scientific value for the energy involved.

**The Impact of Engineering on Society (4.1.2)** When presented as a generic power transformer, the student engineer might not appreciate the consequences of any inefficiencies. However, if prompted to place the generic problem into an engineering context, the students can get a feel for the impact such design decisions have on society. This is particularly so for high-volume manufactured products in a global market. The magnitude of the "Wastage of Standby Power" issue can be further developed by conducting similar calculations for other power electronics components.

**Communication (3.2)** This problem can also be used to teach communication with a lay audience. The total power wasted, if expressed in terms of MJoules or kWhr might not have much meaning for a lay audience, but expressing the same information in terms of cost or number of power stations or number of wind turbines might be useful to make a point.

## ESD Skills Developed:

**Impact of Engineering on the Environment.** Although the power wasted by a single power transformer might be considered negligible, the engineer in charge needs to be conscious that the final product might be produced in enormous volumes. The amplification of industry and global marketplaces is a factor that a modern engineer needs to be aware of.

**Awareness of SD Issues.** The students is made aware of some of the issues involved with wasted electrical power due to inefficient devices, in particular when the devices are mass produced. Each new phone comes with a new charger. Is this necessary / desirable? It might even be constructive to think how much physical space is occupied by $1.5 \times 10^9$ mobile phone chargers, and to consider the waste issues involved.

The societal component of 'Sustainable Development' requires that we consider "how these things serve the needs and quality of life of people and their communities". Mobile phones are a good topic to consider in this regard.

Slide 13 in the Introduction to ESD, reproduced here as Figure 1, indicates that engineers have a choice as to whether they spend their lives carrying out projects that meet basic needs or those that develop a market for highly environmentally damaging luxury goods. Where do mobile phones fall in the chart shown in Figure 1?