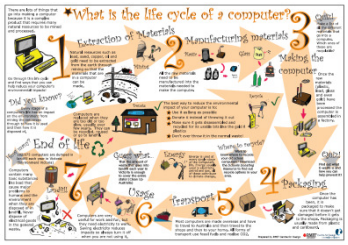
The life cycle of a computer
Teachers Resource



Use this resource in conjunction with the "Computer life cycle" poster available on the ResourceSmart Schools: AuSSI Vic Waste Module CD and the CERES Sustainability Hub: http://sustainability.ceres.org.au

The computer making process

1. Extraction of Materials

To make a computer, materials need to be extracted from the natural environment. Materials required to make a computer include: lead, gold, oil to make plastic, glass, copper, aluminium, nickel, zinc, magnesium, tin, tantalum, phosphorus and silver.

Before all of these can be used to make a computer, they have to be removed from the environment in some way. Metals for example have to be mined from the earth and plastic, which is made from oil, has to be pulled up from deep under the earth's surface.

Metals

- → Ferrous metals are magnetic metals which are derived from iron or steel.
- → Iron is a chemical element, which is heavy, hard and grey.
- → Iron rusts easily and is strongly attracted to magnets.
- → Steel is made from iron by combining molten iron with intense heat and carbon.
- → Both steel and iron (ferrous metals) make up roughly 32% of a computer.

Non Ferrous metals

- → Non ferrous metals do not include iron. They consist of metals such as aluminium, nickel and copper.
- → Aluminium accounts for 8% of the earth's crust and is mainly found in rocks and other substances on the earth's surface.
- → Nickel can be distinguished by its silvery white polished appearance and is a fair conductor of heat and electricity.
- → Copper is a good conductor of electricity and is used in most electrical wire. Copper is an un-reactive metal which means that huge lumps of copper metal can be found buried in the ground as nuggets.
- → Non ferrous metals make up about 18% of a computer.

Crude Oil for plastic

- → Crude oil is found in pools deep under the ground and is extracted by drilling deep holes and the pressure makes the oil rush up to the surface where it is captured.
- → Crude oil is used to make many different materials and products that we use in everyday life

Activity: Make a list of the things in your class room that are made without oil.

Note on activity: Most things contain oil in some way. From fabrics to pens to school book covers to carpet and lights, most things in your class room have been made with oil products in some way. This is a good research exercise to do on the internet with the students.

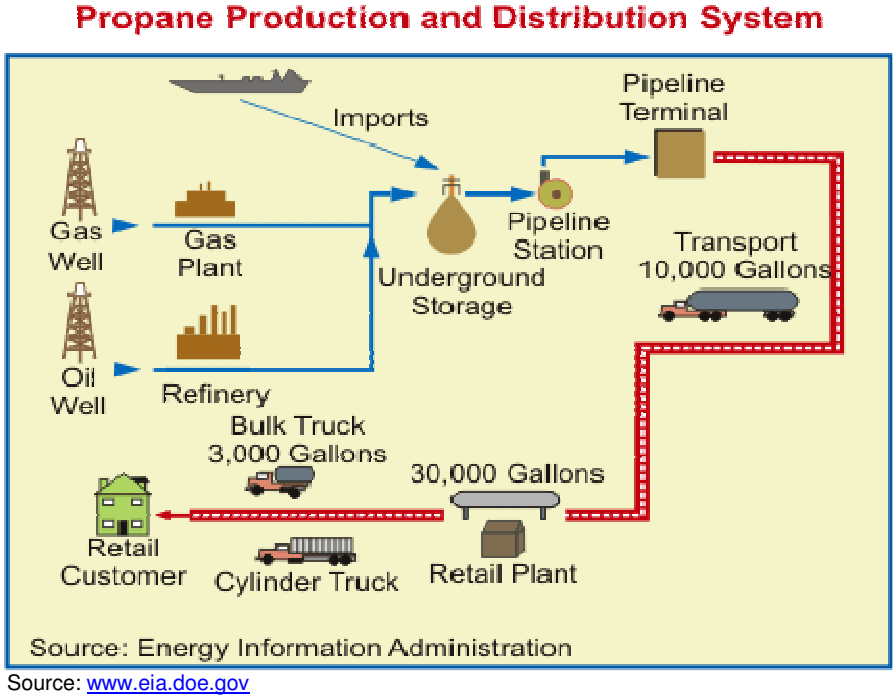
2. Manufacturing Materials

Once the raw materials have been removed from nature they need to be manufactured into forms that can be used. For example metals needs to be transformed from ore to metal.

Plastic

- → To make plastic, crude oil is refined into a variety of hydrocarbons some of which are further transformed into petrol and others into the materials used to make plastics.
- → These include ethane and propane, which are turned into liquefied petroleum gases.
- → These gases are combined with many chemicals which create a reaction called a polymer. The polymer is melted and cooled and made into the shape of a pellet.
- → The pellets are used to make plastic products by processes such as extrusion and injection moulding.
- → 23% of a computer is made up of plastic components.

Quick fact: Making one desktop computer and monitor uses the same amount of chemicals (22kg), water (1500kg) and fossil fuels (240kg) as a mid-size car (Environment Victoria).



Source: www.eia.doe.gov

Activity: Find out what plastics can be recycled in your municipality.

Glass

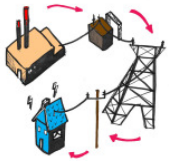
- → Silica (in the form of sand) is the main ingredient of glass. When glass is being made other chemicals are added to make certain colours and give strength.
- → Glass is a made using a mixture of sand (just like the sand at the beach) and other minerals that are melted together in a furnace at extreme temperatures around 1700 degrees Celsius.
- → Items such as bottles, windows and windscreens are made from glass.
- → 15% of a computer includes glass and this is mainly in the screen.

Question: Where does sand come from?
Answer: Sand comes from rocks and stones that have been eroded over time into tiny little bits. A combination of sun, wind, water and natural chemicals slowly make the rocks break up into tiny little pieces.

Lead

- → Lead is a naturally occurring metal, found in small amounts in water and soil. It is considered a toxic substance as it can cause problems when humans and animals are exposed to large amounts of lead.
- → The very small amounts found in nature do not cause any harm to humans
- → Lead is a blue-grey, dense and heavy metal most commonly used in ammunition, batteries, roofing and iron and steel products.
- → A single computer can contain up to 2kg of lead with monitors and screens containing the highest lead content.
- → Lead was once commonly used in gasoline, paints and ceramic glazes but these applications have gradually been phased out due to health concerns.

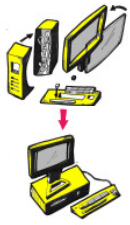
Electronic components



- → A computer is a collection of modular electronic components, know as 'hardware'.
- → The material components of the computer are structured around a main board that is made up of many electronic components such as capacitors, resistors, etc.
- → These components are linked by circuit board connections and connectors which are called the motherboard.
- → In order to work, computers need electricity which in Australia mainly comes from burning coal that is mined.
- → Electronic components make up 12% of the computer.

Activity: Work through the exercises on this webpage and talk about the different types of power and what's best for the environment.
www.mercury.co.nz/education/education_whatisenergy_wheredoeselectricitycomefrom.asp

3. Making the computer



In order to make a computer, all the different components have to be brought together to make the different parts of the computer such as the monitor, keyboard, mouse and hard drive. Different processes are used, such as the plastic is extruded and injection moulded to form the computer casing, and the metals are 'formed', extruded and electro plated to make up all the little bits needed in the computer. Sometimes these parts of the computer are made in different parts of the world and then transported to one location to assemble the final product.

Activity: List some of the potential environmental impacts associated with factories making computers or computer parts.

4. Packaging

A computer and its delicate components require special packaging techniques in order to safely transport it. The computer and monitor is packed separately in bubble wrap, styrofoam and then cardboard boxes to prepare them for the rigors of transportation.

Packaging materials

- → Cardboard is made in a similar way to paper, originating from trees (as explained in the paper LCA poster found on the CERES website)
- → Bubble wrap is made from two sheets of plastic film. The bubbles are made by trapping air between the two sheets of film, which create a cushiony, protective layer.
- → Styrofoam is made from expanded polystyrene beads, which are made from oil. Polystyrene is white and can be expanded to make cups, trays and packaging materials.
- → Goods can be packaged in a variety of ways; individually or in bulk, on shelves, in boxes or in large containers.

5. Transport

To transport a computer a variety of services are used, all dependant upon the distance the computer must travel. Most computers are made overseas and so have to come to Australia on a cargo ship and in some cases they come via air freight. Once they arrive here they have to transported around the country in trucks, trains and vans. The majority of on road vehicles require petrol as do aeroplanes, whilst ships use fuel oil which is a type of diesel. All methods of transportation require energy that results in carbon dioxide being realised into the atmosphere.

> **Activity:** Find out which is the most environmentally friendly way of transporting a computer from Sydney to Melbourne? Is it by car, truck, van, plane, train or something else?

6. Usage

A computer, whether a laptop or a personal computer (PC) is used as a tool to store and transmit information and data as well as have fun and learn things. Computers have helped make some jobs easier and have improved ways of communicating. In recent years there has been a dramatic increase in the number of computers sold and this has had an impact on the environment.

> **Activity:** Ask each student to count how many computers they have at home (including desktops and laptops). Add all the computers in the class up and calculate how many computers your class owns in total.

7. End of life

When a computer is old or too slow, often it is replaced. The computer then has three options. It can be:

1. Donated to a community group or business for reuse
2. Disassembled and recycled
3. Thrown away into rubbish, ending up in landfill

The best choices are 1 and 2. Choosing these options means the computer will have a longer life and reduced environmental impacts.

Helpful resources

- → ABC The Lab - www.abc.net.au/science/features/ewaste/default
- → Choice - www.choice.com.au/viewArticle.aspx?id=103807&catId=100408&tid=100008&p=1
- → Sustainability Victoria - www.ecorecycle.sustainability.vic.gov.au/www/html/1107-byteback.asp?intSiteID=1
- → Environment Victoria - www.envict.org.au/inform.php?menu=6&item=532
- → Generation Ego - www.abc.net.au/science/features/geneco/default
- → When purchasing a new computer check: Electronic product environmental assessment tool: http://www.epeat.net/

Discussion points

- → Each year around 750,000 computers are sold in Victoria totalling 3 million Australia-wide (Environment Victoria).
- → According to Clean up Australia, Australians are the second highest producers of waste per person in the world, with each of us sending almost 690kgs of waste to landfill each year (the United States is the highest waste producer).
- → It is estimated that in 2006 in Australia alone there were around 1.6 million computers disposed of in landfill, 1.8 million put in storage (in addition to the 5.3 million already gathering dust in garages and other storage areas) and 0.5 million recycled (ABC, The Lab).
- → Old computer contains parts that can be reused, such as circuit boards, RAM and a central processing unit (CPU), as well as metal, plastic and other materials that can be recycled (Australian Consumer Association – Choice).
- → Computer equipment collected for recycling is disassembled into their parts (plastic, precious metals, batteries, cathode ray tubes, printed circuit boards, insulated wiring) and sent off to various parts of Australia and the world for recovery and recycling (Byteback).
- → Around 182,875 computers are dumped in landfill each year in Victoria (Environment Victoria)
- → In Europe the Waste Electronic and Electrical Equipment (WEEE) directive makes all companies take back their electronic goods at the end of their life so that they can be recycled.
- → Up to 80% of e-waste collected for recycling in the US is exported to developing nations such as China, India and Pakistan where it is dismantled in dangerous ways that can harm the people and the environment (ABC, The Lab.)

Questions to ask the students

Q: What is a landfill?
A: A landfill is a big hole in the ground that waste is buried in. They are different shapes and sizes and some are for normal waste and some are for toxic waste.

Q: Is there any place in Australia that computers are not allowed to go to landfill?
A: Yes, in the ACT it is banned.

Q: What are the toxic parts of a computer that can harm the environment when it goes to landfill?
A: A typical computer monitor contains lead, barium and hexavalent chromium. Other toxic ingredients include cadmium in chip resistors and semiconductors, beryllium in motherboards and connectors, and brominated flame retardants in plastic casings. 70% of lead, cadmium and mercury in landfill comes from electronic waste (Environment Victoria).

Q: What is more energy efficient a laptop or desk top computer?
A: A laptop in most cases because it charges a battery and then the battery can be used. It is not that efficient when people leave the charging cord plugged in when it is not in use. Always turn the power off at the switch when not in use.