

# WHY RECYCLE?

- **Recycling Saves Natural Resources**
- **Recycling Saves Energy**
- **Recycling Saves our Environment**
- **Recycling Adds Value to your country's Economy**
- **Recycling is Good Business enabling you to make money from trash.**

## Introduction

Environmental problems have become so complex that many individuals feel they can have no effect on them. Problems like global warming, hazardous waste, loss of rain forests, endangered species, acid rain, the ozone layer, the municipal waste crisis can feel out of our control. At the very least, these problems require group and corporate action or government intervention. The Emirates Environment Group EEG is actively engaged in the process.

But there are some things the individual can control. Our waste reduction and recycling activities can make a difference for the world and for our selves.

## SAVE RESOURCES

Our finite reserves of natural resources are being depleted rapidly, particularly with the increasing use of disposable products and packaging. This rate of use and disposal takes a particularly heavy toll on irreplaceable natural resources from our forests and mines. user.

Reprocessing used materials to make new products and packaging reduces the consumption of natural resources. By recycling 454,000 tons of steel in 2001, 567,000 tons of iron ore, 318,000 tons of coal, and 27,000 tons of limestone in a single region. Through recycling newsprint, office paper and mixed paper, we saved nearly 7.5 million trees. Recycling often produces better products than those made of virgin materials; for instance, the tin in "tin" cans is more refined (thus more valuable) after being processed for recycling.

## Plastic Facts

Every day thousand tonnes of plastic is used and disposed in the form of disposable cups to thin cellular packing. Statistics say that about 85 % of these plastics are sent to landfill or dumped elsewhere. This will be a great environmental threat in the coming years. However in the underdeveloped countries and developing countries 40% of plastic is recycled and plastic recycling offers a huge employment opportunity.

Many of the things we use every day, like soda cans, and milk cartons, are made out of plastic that can be recycled. Recycled items are put through a process that makes it possible to create new products out of the materials from the old ones.

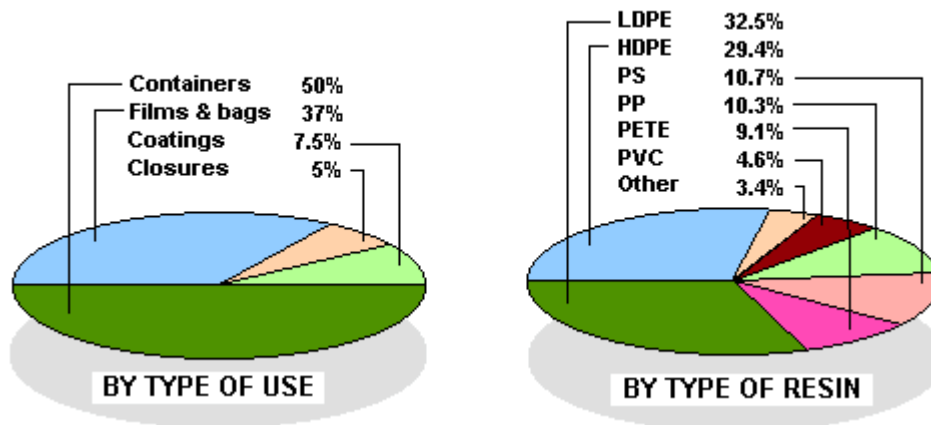
Plastic takes a long time to break down—yet only about 5% of plastic is currently being recycled.

Most of the plastic can be recycled, some more easily than others. The most commonly recyclable types of plastic are polyethylene terephthalate, also called “Plastic #1,” and high-density polyethylene, called “Plastic #2.” Plastic #1 is the type of plastic that soda bottles are made out of. Plastic #2 is the type of plastic used to make milk jugs. You can tell what kind of plastic a container is made out of by looking for a number inside the recycle symbol (usually located on the bottom of the container).

Here we have listed the types of resin and the plastic content in the products .

<b>MAJOR TYPES OF PLASTICS BY S.P.I. CODES</b>			
<b>SPI CODE</b>	<b>TYPE OF RESIN</b>	<b>EXAMPLE PRODUCTS</b>	<b>% OF PLASTIC</b>
<b>1</b>	<b>PET -Polyethylene terephthalate</b>	<b>Soft drink bottles, medicine containers</b>	<b>0.5%</b>
<b>2</b>	<b>HDPE- High-density polyethylene</b>	<b>Milk and water bottles, detergent bottles, toys</b>	<b>21%</b>
<b>3</b>	<b>PVC - Polyvinyl Chloride</b>	<b>Pipe, meat wrap, cooking oil bottles</b>	<b>6.5%</b>
<b>4</b>	<b>LDPE - Low-density polyethylene</b>	<b>Wrapping films, grocery bags</b>	<b>27%</b>
<b>5</b>	<b>PP-Polypropylene</b>	<b>Syrup bottles, yogurt tubs, diapers</b>	<b>16%</b>
<b>6</b>	<b>PS- Polystyrene</b>	<b>Coffee cups, "clamshells"</b>	<b>16%</b>
<b>7</b>	<b>Other</b>		<b>8.5%</b>

### TYPES OF PLASTIC PACKAGING



- Recycling one ton of plastic saves the equivalent of 1,000–2,000 gallons of gasoline
- A one gallon plastic milk container that weighed 120 grams in sixties now weighs just 65 grams.
- 10% of the average grocery bill pays for packaging (mostly paper and plastics) - that's more than goes to the farmers.
- In 1993, plastics accounted for 11.5% of the U.S. municipal waste stream by weight (23.9% by volume). In 1994, plastics comprised 9.5% (by weight) of the waste stream.

- The rate of plastic soda bottle recycling rose from 33% in 1990 to 50% in 1994.
- Products made from recovered plastic bottles include drainage pipes, toys, carpet, filler for pillows and sleeping bags, and cassette casings.

## Paper Facts

- One ton of recycled paper saves 2.5 Cubic Meters of landfill space, 4100 kw hours of electricity (enough to heat a home for 6 months or run a television for 31 hours)
- De-inked paper fiber is the most efficient source of fiber for the manufacturing of new paper products; one ton of de-inked pulp saves over 26500 Cubic Meters of water, 1476 Cubic Meters of oil, and reduces air emissions by 27.2 Kilograms compared to traditional virgin fiber processes
- Enough paper is collected for recycling each year to make a box-car train 7,600 miles long
- 47.3 million tons of papers were recovered In the Kenya. in 2001 - an average of 347 pounds per person
- Everyday Kenya buy 20 million newspapers and throw out 15 million
- One ton of recycled paper uses: 64% less energy, 50% less water, 74% less air pollution and creates 5 times more jobs than one ton of paper products from virgin wood pulp

**Put the following papers in a paper grocery bag or a separate recycling bin. Do NOT use plastic bags.**

### Recyclable Paper

- Magazines
- Catalogs
- Junk Mail and Envelopes (No product samples; envelope labels and windows are OK.)
- Home Office Paper (Manilla envelopes and file folders and paper ream wrappers are OK)

### **These Papers Go In Your Garbage Cart**

- Pizza boxes
- Boxboard (thin cardboard like cereal boxes, shoe boxes, soda cartons, etc.)
- Phone books
- Wet, soiled or food-stained paper
- Paper towels, facial or toilet tissue
- Disposable plates and cups
- Holiday and greeting cards
- Dark-colored envelopes and folders
- Wrapping paper

Even if the papers listed above are collected with your recycling, they will be sorted out later at great expense and sent to a landfill. Please recycle only the paper products listed as recyclable.

### **Rainy Days**

Do not put paper out if it's raining! Wet paper cannot be recycled.

### **Windy Days**

Try placing a brick or another heavy object on top of your paper recycling on windy days. This should keep it from blowing down the street. If you put paper in a recycling bin, stack the second bin with your cans and jars on top of the paper recycling bin.

## **Recycling Rubber**

### **Introduction**

Rubber is produced from natural or synthetic sources. Natural rubber is obtained from the milky white fluid called latex, found in many plants; synthetic rubbers are produced from unsaturated hydrocarbons.

Long before Columbus arrived in the Americas, the native South Americans were using rubber to produce a number of water-resistant products. The Spaniards tried in vain to

copy these products (shoes, coats and capes), and it was not until the 18th century that European scientists and manufacturers began to use rubber successfully on a commercial basis. The British inventor and chemist Charles Macintosh, in 1823, established a plant in Glasgow for the manufacture of waterproof cloth and the rainproof garments with which his name has become synonymous.

A major breakthrough came in the mid 19th century with the development of the process of vulcanization. This process gives increased strength, elasticity, and resistance to changes in temperature. It also renders rubber impermeable to gases and resistant to heat, electricity, chemical action and abrasion. Vulcanized rubber also exhibits frictional properties highly desired for pneumatic tyre application.

Crude latex rubber has few uses. The major uses for vulcanized rubber are for vehicle tyre and conveyor belts, shock absorbers and anti-vibration mountings, pipes and hoses. It also serves some other specialist applications such as in pump housings and pipes for handling of abrasive sludges, power transmission belting, diving gear, water lubricated bearings, etc.

In this brief, we will be looking primarily at the reclamation and reuse of scrap tyres. This is simply due to the fact that this is the major source of waste rubber in developing countries.

### **What is rubber?**

Natural rubber is extracted from rubber producing plants, most notably the tree *Hevea brasiliensis*, which originates from South America. Nowadays, more than 90% of all natural rubber comes from these trees in the rubber plantations of Indonesia, the Malay Peninsula and Sri Lanka. The common name for this type of rubber is Para rubber.

The rubber is extracted from the trees in the form of latex. The tree is 'tapped'; that is, a diagonal incision is made in the bark of the tree and as the latex exudes from the cut it is collected in a small cup. The average annual yield is approximately 2 ½ kg per tree or 450 kg per hectare, although special high-yield trees can yield as much as 3000 kg per hectare each year.

The gathered latex is strained, diluted with water, and treated with acid to cause the suspended rubber particles within the latex to coagulate. After being pressed between rollers to form thin sheets, the rubber is air (or smoke) dried and is then ready for shipment.

### **Synthetic Rubber**

There are several synthetic rubbers in production. These are produced in a similar way to plastics, by a chemical process known as polymerization. They include neoprene, Buna rubbers, and butyl rubber. Synthetic rubbers have usually been developed with specific properties for specialist applications. The synthetic rubbers commonly used for tyre manufacture are styrene-butadiene rubber and butadiene rubber (both members of the Buna family). Butyl rubber, since it is gas-impermeable, is commonly used for inner tubes. Table1 below shows typical applications of various types of rubber

<b>Type of rubber</b>	<b>Application</b>
Natural rubber	Commercial vehicles such as lorries, buses and trailers
Styrene-butadiene rubber (SBR) and Butadiene rubber (BR)	Small lorries, private cars, motorbikes and bicycles.
Butyl rubber (IIR)	Inner tubes.

The raw materials that make up tyres are natural and synthetic rubbers, carbon, nylon or polyester cord, sulphur, resins and oil. During the tyre making process, these are virtually vulcanized into one compound that is not easily broken down.

### **Production of rubber products**

The modern process of rubber manufacture involves a sophisticated series of processes such as mastication, mixing, shaping, moulding and vulcanization. Various additives are included during the mixing process to give desired characteristics to the finished product.

**They include:**

Polymers	Vulcanization accelerators
Activators	Vulcanization agents
Fillers (carbon black)	Fire retardants
Anti-degradants	Colorants or pigments
Plasticizers	Softeners

Fillers are used to stiffen or strengthen rubber. Carbon black is an anti-abrasive and is commonly used in tyre production. Pigments include zinc oxide, lithopone, and a number of organic dyes. Softeners, which are necessary when the mix is too stiff for proper incorporation of the various ingredients, usually consist of petroleum products, such as oils or waxes; pine tar; or fatty acids. The moulding of the compound is carried out once the desired mix has been achieved and vulcanization is often carried out on the moulded product.

### **Vulcanization**

To understand the process of vulcanization it is worth discussing, briefly, the molecular structure of rubber. Crude latex is made up of a large number of very long, flexible, molecular chains. If these chains are linked together to prevent the molecules moving apart, then the rubber takes on its characteristic elastic quality. This linking process is carried out by heating the latex with sulphur (other vulcanizing agents such as selenium and tellurium are occasionally used but sulphur is the most common). There are two common vulcanizing processes.

### **Pressure vulcanization**

This process involves heating the rubber with sulphur under pressure at a temperature of 150°C. Many articles are vulcanized in moulds that are compressed by a hydraulic press (see Figure 1 below).

### **Free vulcanization**

Used where pressure vulcanization is not possible, such as with continuous, extruded products, it is carried out by applying steam or hot air. Certain types of garden hose, for

example, are coated with lead, and are vulcanized by passing high-pressure steam through the opening in the hose.

<b>Truck tire tread (in %)</b>	<b>Passenger vehicle tire tread (in %)</b>
Mineral oil	13 20 –24
Carbon black	30 33 – 37
Rubber – of which	57 40 – 45
Natural rubber	65 25
BR & SBR	35 75

\*Composition of typical tire tread for commercial and passenger vehicles. (TOOL 1996)

#### **Why reclaim or recycle rubber?**

Rubber recovery can be a difficult process. There are many reasons, however why rubber should be reclaimed or recovered;

- Recovered rubber can cost half that of natural or synthetic rubber.
- Recovered rubber has some properties that are better than those of virgin rubber
- Producing rubber from reclaim requires less energy in the total production process than does virgin material.
- It is an excellent way to dispose of unwanted rubber products, which is often difficult.
- It conserves non-renewable petroleum products, which are used to produce synthetic rubbers
- Recycling activities can generate work in developing countries.
- Many useful products are derived from reused tyres and other rubber products.
- If tyres are incinerated to reclaim embodied energy then they can yield substantial quantities of useful power. In Australia, some cement factories use waste tyres as a fuel source.

### **Tyre reuse and recovery in developing countries**

There is an enormous potential for reclamation and reuse of rubber in developing countries. There is a large wastage of rubber tyres in many countries and the aim of this brief is to give some ideas for what can be done with this valuable resource. Whether rubber tyres are reused reprocessed or hand crafted into new products, the end result is that there is less waste and less environmental degradation as a result.

In developing countries, there is a culture of reuse and recycling. Waste collectors roam residential areas in large towns and cities in search of reusable articles. Some of the products that result from the reprocessing of waste are particularly impressive and the levels of skill and ingenuity are high. Recycling artisans have integrated themselves into the traditional market place and have created a viable livelihood for themselves in this sector. The process of tyre collection and reuse is a task carried out primarily by the informal sector. Tyres are seen as being too valuable to enter the waste stream and are collected and put to use.

In Karachi, Pakistan, for example, tyres are collected and cut into parts to obtain secondary materials which can be put to good use. The beads of the tyres are removed and the rubber removed by burning to expose the steel. The tread and sidewalls are separated – the tread is cut into thin strips and used to cover the wheels of donkey carts, while the sidewalls are used for the production of items such as shoe soles, slippers or washers.

### **Recovery of rubber**

#### **Recovery**

#### **Alternatives**

There are many ways in which tyres and inner tubes can be reused or reclaimed. The waste management hierarchy dictates that re-use, recycling and energy recovery, in that order, are superior to disposal and waste management options

Kind of recovery		Recovery process
Product reuse	Repair	<ul style="list-style-type: none"> <li>• Re treading</li> <li>• Re grooving</li> </ul>
	Physical reuse	<ul style="list-style-type: none"> <li>• Use as weight</li> <li>• Use of form</li> <li>• Use of properties</li> <li>• Use of volume</li> </ul>
Material reuse	Physical	<ul style="list-style-type: none"> <li>• Tearing apart</li> <li>• Cutting</li> </ul>
	Chemical	<ul style="list-style-type: none"> <li>• Processing to crumb</li> <li>• Reclamation</li> </ul>
	Thermal	<ul style="list-style-type: none"> <li>• Pyrolysis</li> </ul>
		<ul style="list-style-type: none"> <li>• Combustion</li> </ul>
Energy reuse		<ul style="list-style-type: none"> <li>• Incineration</li> </ul>

### Product re-use

Damaged tyres are, more often than not, repaired. Tubes can be patched and tyres can be repaired by one of a number of methods. Re grooving is a practice carried out in many developing countries where regulations are slacker and standards are lower (and speeds are lower) than in the West. It is often carried out by hand and is labour intensive.

The use of retread tyres saves valuable energy and resources. A new tyre requires 23L of crude oil equivalent for raw materials and 9L for process energy compared with 7L and 2L respectively for re treading. Tyres of passenger vehicles can generally be re treaded only once while truck and bus tyres can be re treaded up to six times. Re treading is a well established and acceptable (in safety terms) practice. The process involves the removal of the remaining tread (producing tyre crumb – see later) and the application and vulcanization of a new tread (the ‘camel back’) onto the remaining carcass. In Nairobi about 10,000 tyres a week are received for re treading

Secondary reuse of whole tyres is the next step in the waste management hierarchy. Tyres are often put to use because of their shape, weight, form or volume. Some examples of secondary use in industrialized countries include use for erosion control, as tree guards, inartificial reefs, fences or as garden decoration. In developing countries wells can be lined with old tyres, docks are often lined with old tyres which act as shock absorbers, and similarly crash barriers can be constructed from old tyres. Old inner tubes also have many uses; swimming aids and water containers being two simple examples

### **Material re-use**

The next step in our hierarchy involves the material being broken down and reused for the production of a new product. As mentioned earlier, in developing countries this hand reprocessing of rubber products to produce consumer goods is well established and the variety of products being made from reclaimed tyres and tubes is astonishing. The rubber used in tyres is a relatively easy material to reform by hand. It behaves in a similar manner to leather and has in fact replaced leather for a number of applications. The tools required for making products directly from tyre rubber are not expensive and are few in number. Shears, knives, tongs, hammers, etc., all common tools found in the recyclers' workshop, along with a wide range of improvised tools for specialized applications. Shoes, sandals, buckets, motor vehicle parts, doormats, water containers, pots, plant pots dustbins and bicycles pedals are among the products manufactured.

Another way in which physical reuse can be achieved is by reducing the tyre to a granular form and then reprocessing. This can be a costly process and there has to be a manufacturer willing to purchase the granules. Crumb rubber from the re treading process can be used in this way, as it is a good quality granulated rubber. The reprocessing techniques used are similar to those described in earlier chapters. Granulate tends to be used for low-grade products such as automobile floor mats, shoe soles, rubber wheels for carts and barrows, etc., and can be added to asphalt for road construction, where it improved the properties of this material.

### **Chemical and thermal recovery**

This type of recovery is not only lower in the waste management hierarchy, but is also a higher technology requiring sophisticated equipment. The applicability of such

technologies for small-scale applications in developing countries is very limited. We will therefore look only very briefly at a couple of processes. Chemical recovery is the process of heating waste rubber reclaim, treating it with chemicals and then processing the rubber mechanically.

- **Acid reclamation** – uses hot sulphuric acid to destroy the fabric incorporated in the tyre and heat treatment to render the scrap rubber sufficiently plastic to allow its use as a filler with batches of crude rubber.
- **Alkali recovery** - Reclaimed rubber, treated by heating with alkali for 12 to 30 hours, can be used as an adulterant of crude rubber to lower the price of the finished article. The amounts of reclaimed rubber that are used depend on the quality of the article to be manufactured.

One form of thermal recovery is pyrolysis. This involves heating the tyre waste in the absence of oxygen which causes decomposition into gases and constituent parts. It is a technology which is still immature in the tyre-reprocessing field.

#### **Energy recovery**

Tyres consist of around 60% hydrocarbons, which is a store of energy that can be recovered by incineration. The heat produced can be used directly in processes such as cement making, or to raise steam for a variety of uses, including electricity generation. Again, this technology requires sophisticated plant and its application is limited when looking at small-scale enterprise.

#### **Landfill**

Landfill is the final step in the waste management hierarchy. The landfill disposal of tyres, if properly managed, does not constitute an environmental problem. However, concerns about conserving resources and energy have seen an increasing opposition to land filling. Also, public sanitation and municipal waste management is often ineffective in developing countries and scrap tyres are often found littering the streets.