



RECYCLING PLASTICS

STARTING A BUSINESS

Introduction

Sooner or later, everything we use and consume becomes waste, including all these nice plastic items and plastic bags we use every day. Plastic consumption is rising and with it the amount of plastic ending up as waste. Managing plastic waste is a global problem with increasing amounts of waste in developing countries as well as industrialised nations.

There is a need for environmental sound solutions as environmental considerations gain ground legislation changes all around the world. Sustainable development is at the top of all agendas in the UN, EU and national governments. Better solutions for the rapidly growing amounts of plastic waste are in demand. High prices of virgin materials will also make recycling attractive.

These developments offer opportunities to people in developing countries enabling new economic activities through the collection, sorting and recycling of plastic waste material. This technical brief gives an overview of technical and economical aspects involved in these activities; it is intended primarily for entrepreneurs thinking of setting up their own plastic recycling business and for organisations dealing with communities in urban low-income areas and who seek opportunities either to create or to increase employment.

What are plastics?

Plastics are made up of long chain molecules called polymers. Various types of polymers can be made from hydrocarbons derived from coal, natural gas, oil and organic oils which are transformed into materials with desirable properties. Plastics that can be readily recycled are *Thermoplastics* which means they will soften when heated. *Thermosetting Plastics* harden when heated, are often used in electrical applications and are not suitable for recycling. *Thermoplastics* are light, durable, mouldable, hygienic and economic, making them suitable for a wide variety of applications including food and product packaging, car manufacturing, agriculture and housing products. *Thermoplastics* can be repeatedly reformed into new products and are the focus of this technical brief.



Bowls made from recycled plastic, Galle, Sri Lanka. (Zul / Practical Action)

Environmental concerns of plastics

Plastics have their impact on the environment through all stages of their existence from manufacture, to utilization and disposal. Manufacturing requires significant quantities of fossil fuels, a non-renewable resource. Burning of plastics releases smoke which contaminates the environment. The smoke contains small particulates, hazardous substances and green house gases.

The disposal of plastics products also contributes significantly to their environmental impact. Most plastics are not biodegradable and can persist in the environment for many years. Plastics can cause blockage of drainage and sewage systems resulting in water logging, flooding and spread of water born diseases. With more and more plastics products, particularly packaging, being disposed of soon after their purchase, the landfill space required by plastics waste is a growing concern.

Why recycle plastics?

Recycling plastics has many benefits, it contributes to energy savings and the reduction of greenhouse gas emissions. It also saves non-renewable sources like oil and gas. In addition to that, recycling provides livelihood for millions of people and families in developing countries, either in the form of formal employment or informal economic activities.

Although there is also a rapid growth in plastics consumption in the developing world, particularly due to the increasing demand for plastics from Asia, plastics consumption per capita in developing countries is much lower than in the industrialised countries. However, there is a much wider scope for recycling in developing countries due to several factors:

- Labour costs are lower.
- In many countries there is an existing culture of reuse and recycling, with the associated system of collection, sorting, cleaning and reuse of ‘waste’ or used materials.
- There is often an ‘informal sector’ which is ideally suited to taking on small-scale recycling activities. Such opportunities to earn a small income are rarely missed by members of the urban poor.
- There are fewer laws to control the standards of recycled materials. (This is not to say that standards can be low – the consumer will always demand a certain level of quality).
- Transportation costs are often lower, with hand or ox carts often being used.
- Low cost raw materials give an edge in the competitive manufacturing world.
- Innovative use of scrap machinery often leads to low entry costs for processing or manufacture.

In developing countries the scope for recycling of plastics is growing as the amount of plastic being consumed increases. Collecting, sorting and recycling plastic waste becomes a viable activity.

Types of plastics

The six most common types of plastic can easily be recycled. The plastics industry has voluntarily devised a coding system which makes recycling plastics easier. Table 1 shows these 6 types of plastics with their identification code, general properties and common uses.

Type of plastic	Identification code	General properties	Common uses
Polyethylene terephthalate (PET/PETE)		<ul style="list-style-type: none"> • Clear • Hard • Tough • Barrier to gas and water • Resistance to heat • Resistance to grease/oil 	<ul style="list-style-type: none"> • Mineral water bottles • 2 liter soda bottles • Cooking oil bottles • Powder detergent jars • Fibre for clothing • Fibre for carpets • Strapping • Peanut butter jars

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High density polyethylene (HDPE)		<ul style="list-style-type: none"> • Barrier to water • Chemical resistance • Hard to semi-flexible • Strong • Soft waxy surface • Low cost • Permeable to gas • Natural milky white colour 	<ul style="list-style-type: none"> • Jerry cans • “Crinkly” shopping bags • Film • Milk packaging • Toys • Buckets • Rigid pipes • Crates • Bottle caps
Polyvinyl chloride (PVC)		<ul style="list-style-type: none"> • Transparent • Hard, rigid (flexible when plasticised) • Good chemical resistance • Long term stability • Electrical insulation • Low gas permeability 	<ul style="list-style-type: none"> • Pipes and fittings • Carpet backing • Window frames • Water, shampoo and vegetable oil bottles • Credit cards • Wire and cable sheathing • Floor coverings • Shoe soles and uppers
Low density polyethylene (LDPE)		<ul style="list-style-type: none"> • Tough • Flexible • Waxy surface • Soft - scratches easily • Good transparency • Low melting point • Stable electrical properties • Moisture barrier 	<ul style="list-style-type: none"> • Agricultural films • Refuse sacks • Packaging films • Foams • Bubble wrap • Flexible bottles • Wire and cable applications
Poly propylene (PP)		<ul style="list-style-type: none"> • Excellent chemical resistance • High melting point • Hard, but flexible • Waxy surface • Translucent • Strong 	<ul style="list-style-type: none"> • Yoghurt containers • Potato crisp bags • Drinking straws • Medicine bottles • crates, • plant pots • Car battery cases • Heavy gauge woven bags
Polystyrene (PS)		<ul style="list-style-type: none"> • Clear to opaque • Glassy surface • Rigid • Hard • Brittle • High clarity • Affected by fats and solvents 	<ul style="list-style-type: none"> • Packaging pellets • Yoghurt containers • Fast food trays • disposable cutlery • Coat hangers
Other plastics			Mostly not available in sufficient quantities for recycling

Table 1: Types of plastics and common uses (source: www.recoup.org)

Understanding your plastic recycling business

Before starting a business in the plastic recycling sector, a proper investigation of all factors which might have an influence on the business is essential. By gathering as much information as possible, the entrepreneur is able to develop a comprehensive picture of the activities and prospects of his future enterprise (Source: Vest, 1999).

Three major areas have to be investigated:

- Availability of raw material: Which types of plastics are available? From which places? In which quantities? What is the quality? For what price are people willing to bring the plastic waste? Etc.
- Availability of technology and funds: What type of machinery is necessary? What is consumed during processing (energy, fuel, lubricants, water, etc)? What type of premises is needed? What investment is required? Etc.
- Market prospects for recycled products: Who are my customers? What is the market price? What are the transportation costs? Etc.

It is recommended to make a business plan as it brings ideas and information gathered into a structured format. Furthermore, A Business Plan helps you to

- decide if you should start your business or not
- organize your ideas so that you will start and run your business in the best way
- present your business idea to a lending institution such as a bank to get a loan for your business.

The following manual helps to prepare a business plan for the proposed business:

http://www.ilo.org/public/english/employment/recon/eiip/download/waste_recycle/business_manual.pdf

Collection of waste plastic

An important first step in starting a plastic recycling business is setting up a collection system of waste plastic. A constant supply of raw material to the factory is of utmost importance for the existence of the business. Collection of waste plastic may already happen through the activities of scavengers, middlemen and traders. It is possible to integrate in this system by letting them know that the factory is willing to buy plastic waste material. Another option is to cooperate with the municipality to get involved in collection schemes accompanied with a public awareness campaign. In this way the public can be informed about the advantages of plastic recycling.

Success story:

Name of factory:

Capacity:

Collection of PET bottles in Kampala, Uganda

Plastic Recycling Industries (PRI) Uganda

550 ton in 2009

In December 2006 PRI installed a new production line for the shredding and washing of PE and PET. As a reliable input of raw material is of the utmost importance for the existence of the factory, at the same time PRI set up a very successful collection system for Kampala. Several different activities were executed to achieve this:

1. Execution of a public information campaign using posters, spots on local radio and TV, articles and commercials in newspapers.
2. Training of NGO's and other organizations involved in the collection of plastic waste material.
3. Setting up several collection points in the city.

In this way a simple and reliable collection system exists now in Kampala. In this, communication is a key factor. The message you want to promote must be clear: What types of plastics is the factory buying? How clean and sorted must the plastic waste be to be accepted? How much does the factory pay? Etc.

As a result of this intensive marketing and promotional campaign, more than 100 contracts were established with suppliers of plastic waste materials like hotels, restaurants, schools, NGO's, garbage collectors, petrol stations, supermarkets, etc. Apart from these agreements, many small companies started collecting and selling plastic waste material to PRI.

The impact of these activities is enormous, next to the creation of hundreds of jobs in the collection and transportation of plastic waste, also a great impact on environment is noticeable. Plastic waste lying around in streets is less and it is also noticed that the burning of plastic has decreased in many areas of the city.

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Photo 2: Collectors of PET bottles in Uganda (Patrizia Sterenburg)

Processes and equipment required for plastic recycling

Figure 1 gives an overview of processes which can take place in a plastic recycling plant. With each step the value of the waste material increases, as the value of waste plastic as a secondary resource depends on its purity and composition.

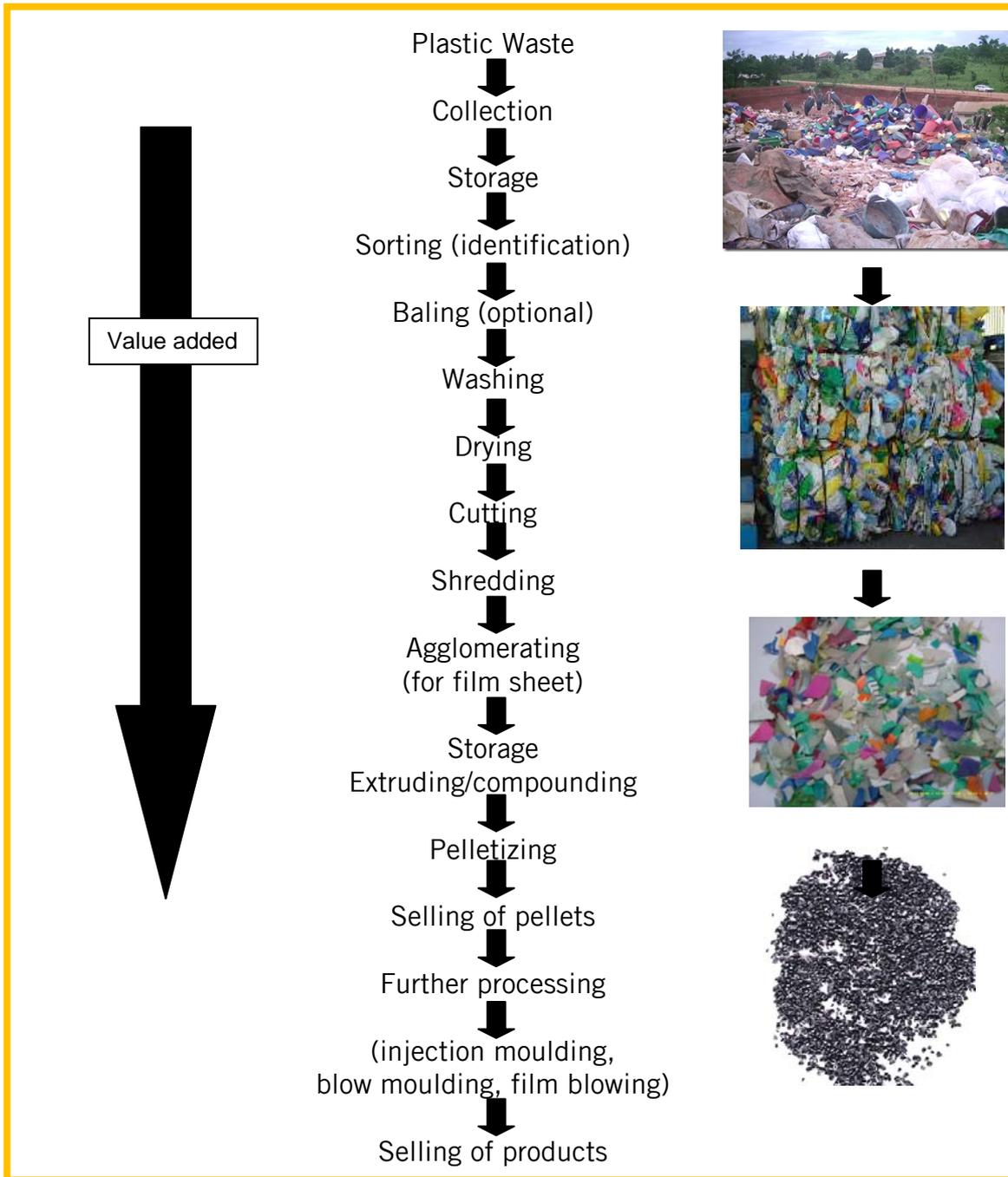


Figure 1: simplified scheme of plastic recycling

Storage

The plastic recycling enterprise needs quite a large storage space in order to store all collected waste items, processed materials and finessed products. Plastic waste items, especially bottles, have a large volume and therefore a large storage place is necessary.

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Sorting and identification

Plastics sorting operations may be carried out manually or automatically using appropriate means of identification. The more accurate and efficient the means of identification, sorting and separation, the better is the quality of the recovered product obtained. Best suited for sorting plastics in developing countries are those technologies that make extensive use of the (comparative) advantage of cheap labour. The secondary raw material obtained by hand sorting is of high quality and offers an excellent basis for producing high quality products by small and medium scale industry (Vest, 2000).

To aid in identification, it is now common for plastic containers to have a polymer identification code (see table 1). Unfortunately, other plastic applications do not carry such identifiers and are, therefore, more difficult to identify by polymer type without some experience. There are several simple tests that can be used to distinguish between the common types of polymers so that they may be separated for processing.

The water test.

After adding a few drops of liquid detergent to some water put in a small piece of plastic and see if it floats.

Burning test.

Hold a piece of the plastic in a tweezers or on the back of a knife and apply a flame. Does the plastic burn? If so, what colour?

Fingernail test.

Can a sample of the plastic be scratched with a fingernail?

Test	PE	PP	PS	PVC*
Water	Floats	Floats	Sinks	Sinks
Burning	Blue flame with yellow tip, melts and drips.	Yellow flame with blue base.	Yellow, sooty flame – drips.	Yellow, sooty smoke. Does not continue to burn if flame is removed
Smell after burning	Like candle wax.	Like candle wax – less strong than PE	Sweet	Hydrochloric acid
Scratch	Yes	No	No	No

To find out more about identifying different types of plastic bottles:
www.plasticsrecycling.info or www.recoup.org/business/understand_essential.asp

Baling

After collecting and sorting the plastic material the option exist to sell the material to (other) processing units. Especially when transporting distances are considerably, it is important to compact the waste to improve handling and save costs during transport. In order to obtain a

Washing

If the plastic is dirty, cleaning is necessary. The main cleaning steps are:

- Draining of remaining fluids from containers into prepared collection barrels.



Photo 3: Simple baler for PET bottles as used in Belarus (Sophie van den Berg)

- Rough cleaning of plastic containers and other pieces of plastic.
- Removing of paper, plastic or metal stickers.
- In the case of PET bottles removing of caps and etiquettes.
- Intensive washing in cold or hot water with addition of detergents or caustic soda. The waste water can be reused by installing a simple waste water treatment system like a sedimentation basin.

*When plastic waste is sorted to type, the price per kilo increases substantially.
 When the plastics are further sorted to colour, the price increases more.
 When the plastics are baled, the price increases more.
 Large quantities give better negotiation positions.*

Cutting

Cutting is usually carried out for initial size reduction of large objects. It can be carried out with scissors, shears, saw, etc.

Shredding

Shredding is suitable for smaller pieces. A typical shredder has a series of rotating blades driven by an electric motor, some form of grid for size grading and a collection bin. Materials are fed into the shredder via a hopper which is sited above the blade rotor. The product of shredding is a pile of coarse irregularly shaped plastic flakes which can then be further processed.



Photo 4: Shredder in Peru (Simone Ransijn)



Photo 5: Agglomerator operating in Benin (Heino Vest)

Agglomeration

Clean film sheet is processed in an agglomerator. The agglomerator consists of a vertical drum with a set of fast moving blades in the bottom. The agglomerator chops the sheets into thin film flakes. Due to the cutting and friction energy of the process, the flakes are heated until they start to melt and form crumbs or agglomerate. This will increase the bulk density of the material which is now fit to be feed directly into the extruder.



Photo 6: Example of a pelletizer in India (Heino Vest)

technical brief

Pelletizing

For many purposes it is recommended to convert plastic flakes or agglomerate (crumbs) into pellets before processing. The plastic pieces are fed into the extruder, are heated and then forced through a die to form a plastic spaghetti which can then be cooled in a water bath before being chopped into pellets.

Success story: Galle, Sri Lanka,

Description of the enterprise:

Woman of the waste recycling project, outside the recycling factory with the pellets that are produced. The project was carried out in conjunction with a micro credit organisation and with assistance from Galle Municipality. Householders are able to generate a nominal income by participating in this community scheme which is concerned with solid waste management. Community members collect waste and separate it into bags - plastic, metal, glass and biodegradable material – ready for further processing and recycling.



Photo 7: Woman of the waste recycling project, Galle, Sri Lanka. (Practical Action / Zul)

Further processing

Extrusion. The extrusion process used for manufacturing new products is similar to that outlined above for the process preceding pelletisation, except that the product is usually in the form of a continuous 'tube' of plastic such as piping or hose. The main components of the extrusion machine are shown in Figure 2 below. The reclaimed plastic is forced along the heated tube by an Archimedes screw and the plastic polymer is shaped around a die. The die is designed to give the required dimensions to the product and can be interchanged.

Injection moulding. The first stage of this manufacturing process is identical to that of extrusion, but then the plastic polymer emerges through a nozzle into a split mould. The quantity of polymer being forced out is carefully controlled, usually by moving the screw forward in the heated barrel. A series of moulds would be used to allow continual production while cooling takes place. See Figure 2 below. This type of production technique is used to produce moulded products such as plates, bowls, buckets, etc.

Blow moulding. Again the spiral screw forces the plasticised polymer through a die. A short piece of tube, or 'parison' is then enclosed between a split die -which is the final shape of the product - and compressed air is used to expand the parison until it fills the mould and achieves its required shape. This manufacturing technique is used for manufacturing closed vessels such as bottles and other containers. See Figure 2 below.

Film blowing. Film blowing is a process used to manufacture such items as garbage bags. It is a technically more complex process than the others described in this brief and requires high quality raw material input. The process involves blowing compressed air into a thin tube of polymer to expand it to the point where it becomes a thin film tube. One end can then be sealed and the bag or sack is formed. Sheet plastic can also be manufactured using a variation of the process described.

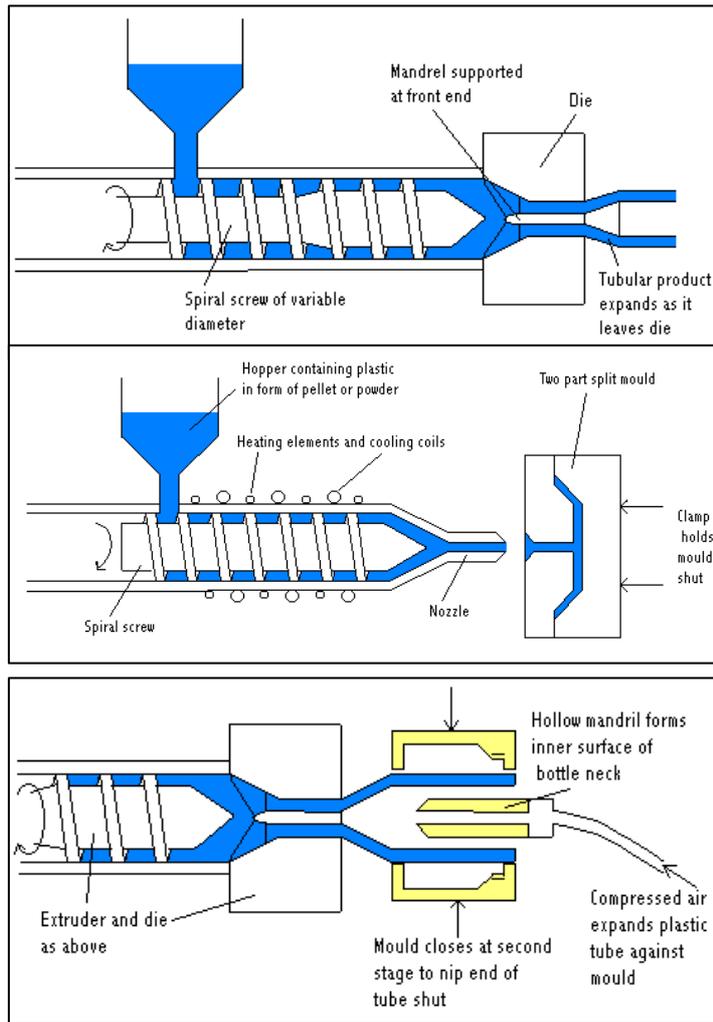


Figure 2: Plastic manufacturing techniques; extrusion (top), blow moulding (middle) and injection moulding (bottom).

Environmental policy

The existence of government support schemes are very helpful to start a plastic recycling unit. When laws and regulations are enforced promoting recycling, it often is much easier to obtain the necessary permits needed for the company.

The recycling business needs to strive to mitigate adverse effects that may arise due to its operations and products through cleaner production technologies; this involves proper waste/effluent management, prevention of any possible pollution, cooperation with relevant national and local environment regulatory bodies and compliance with all available environmental laws and regulations.

Recycled plastic products

There is an almost limitless range of products that can be produced from plastic. However, the market for recycled plastic products is limited due to the inconsistency of the raw material. Many manufacturers will only incorporate small quantities of well-sorted recycled material in their products whereas others may use a much higher percentage of recycled polymers. Much depends on the quality required.



Photo 8: Extrusion of water pipes, Nepal (Sophie van den Berg)

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In developing countries, where standards are often lower and raw materials very expensive, there is a wider scope for use of recycled plastic material. The range of products varies from building materials to shoes, kitchen utensils to office equipment, sewage pipe to beauty aids.

Success story: Ragbag

Ragbags are fashionable products made from recycled plastic bags by deprived people in the slums of Delhi. The production is done by Conserve, a Delhi based NGO. They work with rag pickers, who collect the plastic waste, collection centers where they wash and clean the bags. Then the bags are sorted on colours and pressed to thicker sheets. Finally they go to small fabricators who make them into new products. The project is already creating jobs for more than 100 ragpickers, people at collection centers and fabricators in New Delhi, providing them and their families 'means of livelihood' and gain access to more opportunities.

Ragbag products are designed by young European designers. The Ragbag collection consists of the following products: shoulder bags, organizers and wallets. They are sold in shops in Netherlands, Germany, UK, Australia, US and through the website.

More info: www.ragbag.eu

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References and further reading

- [Planning for Municipal Solid Waste Management](#) Technical Brief
- [Transport for Waste Management](#) Technical Brief
- [Recycling of Rubber](#) Technical Brief
- *Plastic Waste - Options for small-scale resource recovery*, Lardinois, I., and van de Klundert, A. 1995, ISBN: ISBN 90-70857-34-0 Gives many examples of successful plastics recycling operations in developing countries
<http://www.waste.nl/content/download/284/2234/file/UW2%20PLASTIC%20ebook.pdf>
- *Small-scale recycling of plastics*. Vogler, Jon, Intermediate Technology Publications 1984. A book aimed at small-scale plastics recycling in developing countries.
http://www.waste.nl/content/download/560/4328/file/Pla-vogler_ebook.pdf
- *Work from Waste*. Vogler, Jon, Intermediate Technology Publications 1981. A classic text for those recycling wastes to create employment.
- *Introduction to Plastics Recycling*, Goodship, V, RAPRA, 2007, ISBN 978-1-84735-078-7
- *Guidelines for the Promotion of Small Scale Recycling Projects*, Vest, H., GATE Information Service, 1999.
- *Small Scale Recycling of Plastic Waste*, Vest, H., GATE Information Service, 2000
- *Start your waste recycling business, a technical step-by-step guide of how to start a community-based waste recycling business*, ILO, October 2007
- *Plastics – Guidelines for the recovery and recycling of plastics waste, NEN-ISO 15270, June 2008*

Useful addresses

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Rapra Technology is Europe's leading independent plastics and rubber specialist organisation, providing research, technology and information services for the polymer industry and for industries using polymers in their products or processes.

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Advisers on Urban Environment and Development, specialists on solid waste in South countries. Most documents available for free downloading.

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Produces a range of literature on plastic consumption, production and recycling

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CEMPRE is a non-profit association dedicated to the promotion of recycling within the scope of integrated waste management and provides many publications and market information.

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The Warmer Bulletin' published 4 times a year (subscription required)

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Provides details of plastic recycling, market information, material identification and promotional material

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SWAPP is a non-profit membership organization composed of solid waste practitioners and executes various solid waste projects

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Regional offices in Colombia, Bolivia and Zimbabwe. Database, library, publications and advice. Quarterly magazine 'African Environment'

Manufacturers of plastics recycling equipment

Note: This is a selective list of suppliers and does not imply endorsement by Practical Action.

www.pimcomachine.com

www.himalayagranulator.com

www.asianmachineryusa.com

For more manufacturers of recycling machinery all over the world, see www.alibaba.com

Used machinery:

www.plasplant.com

www.upm.nu

www.holzmag.de

Internet addresses

www.cwgnet.net	Website of the Collaborative Working Group on Solid Waste Management in Low- and Middle-Income Countries (the CWG). Has access to articles, conference proceedings, networking information, and a working group on the global informal sector in solid waste.
www.ilo.org	Website of the International Labour Organization. The ILO has a wide variety of very useful publications on solid waste services by and for the poor, including "Start your own Waste Collection Service ; Business Plan "
www.iswa.org	Website of the International Solid Waste Management Association. ISWA publishes Waste Management World, www.waste-management-world.com
www.skat.ch	A Swiss NGO consultancy. Secretariat of the CWG, and specializes in the Brown environmental agenda
www.worldbank.org/solidwaste	Website of the World Bank. Contains, has a great deal of very good information on solid waste management in developing countries
www.unep.or.jp/ietc/issues/Urban.asp	Website of the former office of UN-International Environmental Technology Center in Japan, publisher of the UN Solid Waste Source Book.

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