RESOURCE RECOVERY

RESOURCE RECOVERY/ DOWNCYCLING AND ITS VARIOUS FORMS

CONTENTS

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INTRODUCTION

By watching this video you are going to learn about the basics of resource recovery/downcycling.

The video introduces the definition resource recovery/ downcycling and presents its various forms, explaining how it can contribute to sustainability and circular economy.

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EXPECTED LEARNING OUTCOMES

KNOWLEDGE	• Knowledge of what resource recovery/ downcycling is • Knowledge of processes and products that are conducive to resource recovery. • Knowledge of case studies where businesses have been developed using resource recovery
SKILLS	• Discuss what resource recovery/ downcycling is, and how it could be adapted to a larger scale project • Research waste products that are readily available and brainstorm alternative products that could be produced from these products
ATTITUDES	• Appreciation of how resource recovery/ downcycling can be used to extend the life of lower quality materials. • Acknowledge how waste products can be turned into higher value products through resource recovery • Research and use key terminology related to resource recovery/downcycling.

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SELF-REFLECTION EXERCISE

Welcome! You can access our initial quiz via the link that will map your basic knowledge in this topic. And do not no worry, by the end of the chapter you will know the answer to everything!

https://docs.google.com/forms/d/16gE_QX3a6tB2Bhr2FjsLIfcHXIzmh6O_m4vgwr_cxg8

FORMS OF RESOURCE RECOVERY: DOWNCYCLING AND HOW IT RELATED TO UPCYCLING AND RECYCLING

The goals of resource recovery are to prevent useful materials from going to waste and to reduce the consumption of raw materials. The process also saves on the energy that would be used to create new products from raw materials. By avoiding the expense of new materials production, costs and energy use are reduced, and by offering an alternative to discarding old products, environmental waste is cut down.

There are three methods of renewing the value and quality of a used or waste material: upcycling, recycling and downcycling. In fact, downcycling and upcycling are actually **recycling trends.**

Downcycling, converts a discarded material into something of less value than it originally was.

Downcycling recycles waste that cannot be made into a higher quality product in its present form. The goal of the process is to transform materials with low quality and functionality into materials that can be used to create new products.

Example:

- Used clothes converted into cleaning rags
- Used papers transformed into craftpaper
- Old Apple products are taken in and stripped of any valuable materials that can be reused, new Apple products can then be created with the downcycled materials.

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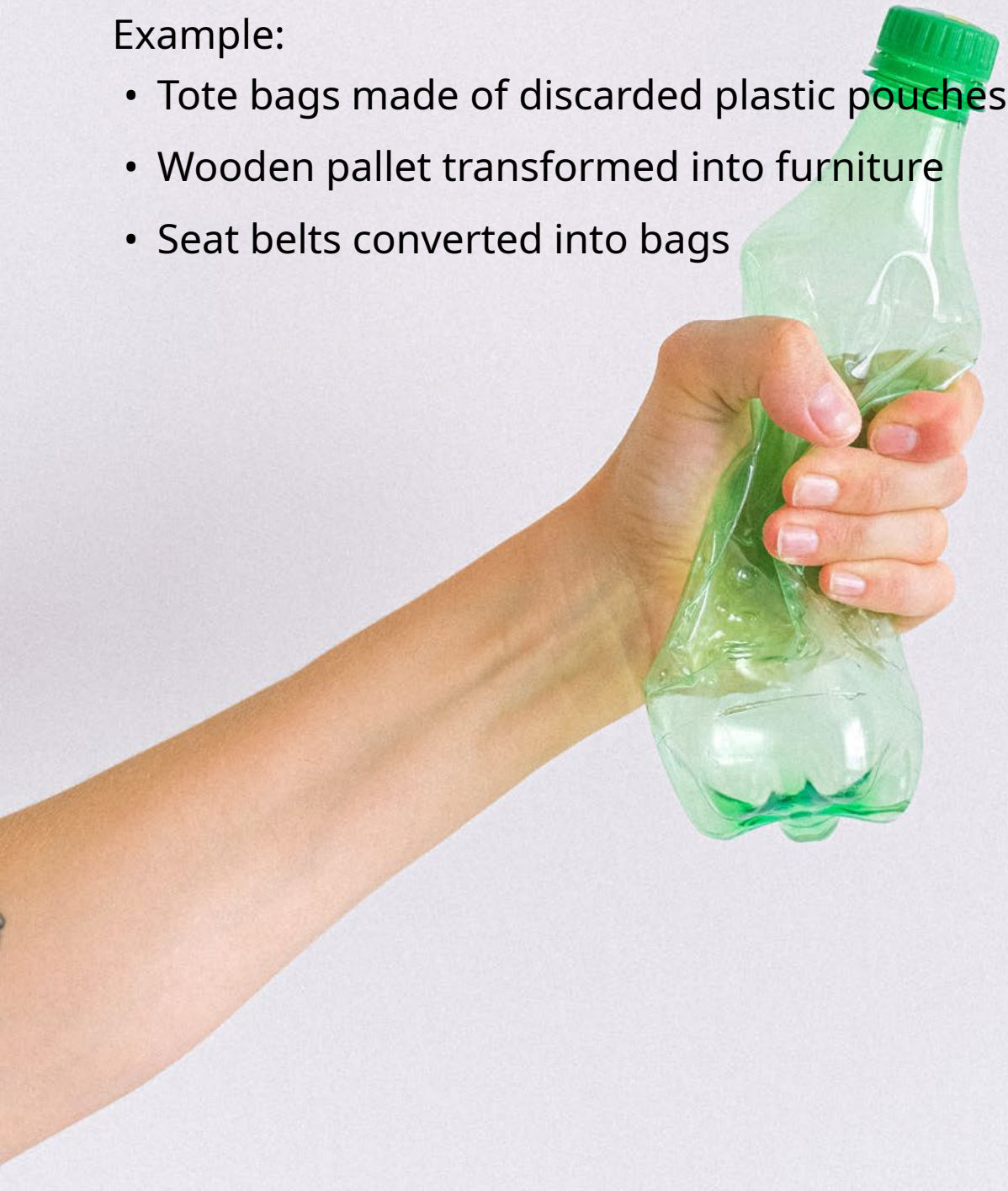
Upcycling, the opposite of downcycling, is the process of providing new high quality products by using by-products (waste or unwanted products). The original form of the product is maintained.

Upcycling is in fact the innovative, creative reuse of materials. Unlike recycling, it does not aim merely to reuse waste materials but to reuse them in such a way that their intrinsic value or quality is enhanced. It prevents wasting potentially useful materials by making use of existing ones, so moving resources back up the supply chain.

Example:

- Tote bags made of discarded plastic pouches
- Wooden pallet transformed into furniture
- Seat belts converted into bags



Recycling
Converts a material into something about of the same (equal or lower) value as the original as the process simply breaks down the product to its basic components to produce something new out of the same material.

It is a more industrial process, requiring more energy and resourcesthan upcyling.

Realistically however, a significant portion of recycling is actually downcycling, as certain materials result in a lesser quality material when recycled.

In many cases recycling can only be done a few number of times (e.g. plastic).

Recycling lenghtens the life of the materials but only delays the problem of landfill, is not assuring designing out waste.

Example:

- Cardboard made of waste paper
- Crashing glass to make cullet, which can be used for: new bottles, jars,
-
- Melting PET bottles to make a toy, carpet
- Plastic, metal, wood, glass, textiles recycling

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WAYS OF RESOURCE RECOVERY

RESOURCE RECOVERY FROM WASTE

Millions of tons of waste is generated by humans every day. This waste is rich in energy, water, nutrients, or organic compounds. Yet waste is not being managed in a way that permits us to derive value from its reuse, whilst large populations around the world struggle with depleted soils, lack of water, lack of access to electricity and modern fuels.

Below you are presented two cases showing how Resource Recovery from Waste (RRfW) could support livelihoods, support green economies, reduce waste and contribute to cost recovery.

SOLID FUEL PRODUCTION FROM WASTE - BRIQUETTES FROM AGRO-WASTE

Urban and rural populations in developing countries mainly depend on traditional biomass fuels such as charcoal and firewood for cooking due to lack of affordability and access to modern fuels. Despite more than a decade of work to reduce domestic air pollution sources, progress toward universal access to clean cooking fuels remains far too slow.

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Overdependence on firewood has resulted in reduced availability and consequently necessitates the efficient utilization of agricultural residues and municipal solid waste as a source of heating and cooking fuel by transforming them into alternative fuel products called briquettes.

Kampala Jellitone Suppliers (KJS) is a limited company located in Kampala, Uganda that produces noncarbonized briquette from agricultural residues. KJS has been operational since 1981 and at the time of the assessment employed over 100 people, 70% being women. The company started with roasting coffee using diesel burners, followed by a bakery that used firewood ovens. The baking and roasting propelled the need to look for an alternative fuel source and gave rise to the production of briquettes made from agricultural waste. This has led to KJS becoming the first large scale non-carbonized briquette producer in Uganda and wining the ASHDEN Global Green Awards in June 2009. Its clients now include institutional and commercial users who previously used wood fuel and charcoal for cooking and heating. KJS provides them with briquettes which have high heating value and consistent properties and burn longer than alternative cooking fuel, as well as selling efficient briquette-burning stoves. The company has also set up the Fuel from Wastes Research Centre (FWRC), an NGO which conducts innovative research and development in suitability of agricultural wastes for briquetting, briquette making, and designing and manufacturing of briquette burning stoves.

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The KJS Business Model

KJS implements a value-driven business model. The establishment and partnership with the Fuel from Wastes Research Centre has enabled KJS to be innovative in its use of varieties of agricultural waste, in making consistent quality briquettes and in designing efficient stoves (Figure 8). Briquettes are sold via distributors while briquette stoves are customized and installed at the user's site. The company provides its briquette and stove customers pre-sales and post-sales support by giving a training/ demonstration on how to use the products. It also conducts sensitization and training workshops for farmers on the best ways possible to preserve the agricultural wastes by milling it before delivery to allow the transport of larger quantities as well as for end users on how to use the briquettes and stoves effectively and efficiently to get value for their money. Thanks to these practices, KJS has been making profits for the last five years and has plans to scale up its operations by targeting industries which rely on biomass for industrial energy supply, such as cement factories, bricks, tile production, etc.

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Energy from manure and agro waste for rural electrification

Santa Rosillo, a rural community in the deep jungle of the Peruvian Amazon in northern Peru, is more than 16 to 21 hours away from the nearest city, Tarapoto, and is only accessible by boat and on foot. Santa Rosillo consists of 42 households (220 people) who have an average monthly income ranging between USD 23 and USD 47. Due to the extreme remoteness of the village, prior to this project, most of the community did not have access to electricity and relied on candles, batteries and lighters for domestic lighting. Approximately 12% of the population had access to electricity through private diesel generators. In 2010, SNV Netherlands Development Organisation (SNV), a non-profit international development organization, in partnership with the regional government initiated a rural electrification project to install two bio-digesters in the village linked to a power generator and mini-grid to provide electricity to the community. The community's primary economic activity is livestock and agriculture (cocoa), and all organic waste is fed into the two bio-digesters. The biogas generated is fed into the electricity generator and electricity is distributed to each house. The installed electrical capacity is 16 kW which provides electricity to 42 houses, the local doctor's office, the local college and public lighting for approximately Copyright Material – Provided by Taylor & Francis CASE: POWER FROM MANURE AND AGRO-WASTE FOR RURAL ELECTRIFICATION SECTION II: ENERGY RECOVERY FROM ORGANIC WASTE 153 5.3 hours per day.

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Approximately 60% of the slurry by-product produced by the bio-digesters is then used as fertilizer to improve the soil quality of the communal grazing area, while the remaining 40% is sold to local farmers. Commercial Industrial Delta SA (CIDELSA), a Peruvian engineering company, supplied the two lagoon bio-digesters for the project.

GREEN ENERGY BY DOWNCYCLING

Case studies of Veolia

Veolia Group, with branches worldwide, designs and provides game-changing solutions that are both useful and practical for water, waste and energy management. Through its three complementary business activities, Veolia supports developing access to resources, preserve available resources, and replenish them.

Achievements of the Group in 2020:

WATER

- **95** million people supplied with water
- **2,667** wastewater treatment plants managed
- **3,603** water production plants managed
- **63** million people connected wastewater systems

WASTE

- **560,505** business customers
- **49** million metric tons of treated waste
- **655** waste-processing facilities operated
- **43** million people provided with collection services on behalf of municipalities

ENERGY

- **42,053** thermal installations managed
- **615** heating and cooling networks managed
- **46** million MWh produced
- **2,389** industrial sites managed

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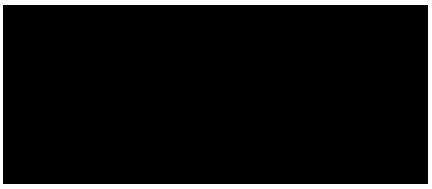
Turning household waste into energy in United Kingdom
Veolia supports the London Borough of Southwark in its domestic waste recovery activities with an ultramodern waste management center opened in 2012.



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The waste management facility of Southwark has a sorting center that isolates high quality materials, a recycling center treating household waste and bulky waste, and a mechanical-biological treatment unit dedicated to recovering biodegradable waste.

Efficient sorting techniques and innovative treatment units mean the district can process 120,000 tons of waste per year and achieve a recycling rate of 40%, and it shows an increasing tendency.

Veolia is similarly responsible for transforming biodegradable waste from the mechanical-biological treatment process into fuel. The fuel is transported to the South East London Combined Heat and Power co-generation plant to generate electricity and heat for 2,600 Southwark homes. Compared to using gas boilers, co-generation this solution avoids the emission of almost 8,000 metric tons of CO2 equivalent per year.

This solution not only contributes to increase the share of renewables in the UK's energy mix, but also to meet the 2020 target set by the European Union to reduce by 35% the amount of municipal biodegradable waste sent to landfills compared to 1995 volumes.

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Thermal energy from wastewater - Swimming pools heated with wastewater in France

An increasing numbers of local authorities are inventing and implementing eco-responsible solutions to fight against climate change. Recovering the energy present in the form of heat in wastewater is a perfect illustration.

In order to reducing their environmental footprint and reducing their energy expenditure and dependence, more and more cities are turning to renewable sources of energy: hydraulic, wind, geothermal, biomass, etc.

Veolia's Energido solution offers cities the possibility of recovering heat from municipal wastewater. This reduces primary energy consumption, generates energy from a local resource, is available in abundance, and efficiently distributes the energy produced.

Energido is a solution that diverts some of the city's wastewater to a heat exchanger in order to transfer the energy it contains to a heat transfer fluid. The recovered calories are sent through a reversible heat pump which is able to release the energy to supply a heating or cooling network. This is how Energido is able to offer all year round energy efficiency.

Thanks to Energido, Veolia heats for instance the pools of the prestigious Cercle des Nageurs de Marseille (CNM). This solution keeps the temperature of the Olympic swimming pools at 27°C all year round and preheats the hot water for the changing rooms too. Not only does the CNM save 35% on its annual energy bill, but 230 metric tons of CO_2 emissions are also avoided every year.

RESOURCE RECOVERY BUSINESS MODEL

The Resource Recovery business model is based on transforming waste into secondary raw materials. The goal of this model is to obtain supplementary uses from resources and to extract more value from them by avoiding final disposal for as long as possible. This model reduces the need for new, virgin resources by reusing waste and converting it into a resource. Adopting this model successfully depends on identifying ways of recovering end-of-life products, so that the valuable materials and the energy that went into producing them can be reused. An in-depth evaluation of how to recover waste and by-products from each step of the production is a key analysis for successful implementation of this model.

The Resource Recovery business model utilizes technological innovations and advancements to recover and reuse resource outputs. A real world example is recycling plant material, food scraps or paper products through biological composting processes. The resulting material can then be used as mulch or compost, and the waste gases, such as methane, can be captured and transformed into electricity or heat. Companies that adopt this model can reduce or eliminate waste of byproducts and maximize the value they are extracting from their resources. This model accomplishes this goal by reprocessing waste materials into new resources that can be used again once or many times.

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Some of the examples of this model in the real world include:

- Recovering energy from product destruction

Fuel blending is often the safest and most efficient option for destroying both hazardous and non-hazardous waste. The energy generated from the combustion can be recovered in some operations and used in the creation of concrete.

- Reusing food and agricultural waste

Instead of discarding organic waste like food and agricultural products in a landfill, there are now processes to convert that waste into biomethane gas. That gas is then used to create electricity or hydrogen for battery or fuel cell electric vehicles.

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- Recovering oil and wastewater for reuse

During the production of petroleum and other fuel products, oily sludge is produced as a byproduct. Through an innovative recycling process, refineries recover value from used resources by using a treatment process that separates the oil, water and solids. Once separated, the recovered oil and water is then returned to the refinery for reuse in crude processing. Resource recovery business models involve the production of secondary raw materials from waste streams. There are three main activities involved:

- Collection - involves the collection of the waste materials generated by households, businesses, and industry; it is generally organised by local governments
- Sorting - involves separation of a particular waste stream into its constituent materials; in some cases it is undertaken in public facilities and/or by the private sector
- Secondary production - involves the transformation of sorted waste material back into finished raw materials; it is generally undertaken by firms operating in the private sector. The resulting secondary raw materials – metals, plastics, paper, glass, etc – are then sold to various manufacturing/production firms.

The business case based on the resource recovery models focuses on the valorisation of the materials contained in waste streams.

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Raw waste is available at little or no cost; indeed the households and firms that generate it are often willing to pay to have it taken away. At the same time, finished secondary raw materials fetch significant prices on commodity markets. The challenge companies adopting the resource recovery model need to deal with is ensuring that the unit cost of undertaking this valorisation process is sufficiently small as compared to the market price of finished materials.

Adoption of the resource recovery business model is only likely under certain conditions. First, there needs to be a market for secondary raw materials. Concerns about the quality or composition of these materials mean that this is not always the case. Some technologically advanced sectors (aerospace for example) tend to avoid recovered materials because of uncertainty about their performance characteristics in extreme conditions. Similarly, food packaging providers in some countries are unable to use recovered plastics and paper due to hazardous chemicals regulation. Second, adoption of the business model requires that a sufficient volume of waste material being generated. This is not always the case, especially in regions characterised by low population density or low level of consumption. Although the transport of waste to central processing facilities is technically possible, it is not always economically feasible given the bulky and low value character of many waste streams.

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There are many benefits to adopting a Resource Recovery circular business model. The first is the potential financial advantage possible for companies. For businesses that can find an efficient, cost effective way to recycle and reuse waste, they may be able to recover the resource at a value that is equivalent to, or even above, the initial investment. This opportunity can be significant, particularly for companies that produce large volumes of by-products.

Besides the financial advantage of new revenue streams or cost reductions, a driver of the Resource Recovery model may be to satisfy the environmentally conscious consumer.

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DOWNCYCLING PLASTIC

Downcycling (recycling in fact) is flawed, especially when it comes to plastic. Plastic declines in value and strength every time it is recycled, until it is eventually rendered useless.

Glass, paper, and metal (including aluminium) are all highly recyclable without losing quality or purity of the product. There's no need to add additional virgin material in the recycling process– recycling glass and metal is the ultimate form of circular economy, the process of using and then reusing materials without generating any waste.

These materials can be broken down, refashioned, and reused with almost no noticeable changes in durability or usability. It is the plastics, where we see the most prevalent examples of the degrading nature of downcycling.

Additionally, the process of downcycling (recycling) plastics is less transparent than we think. It is a system dictated by market demand, price determinations, local regulations, the success of which is contingent upon everyone, from the product-designer, to the trash-thrower, to the waste collector, to the recycling factory worker.

How does downcycling work in terms of plastic?
There is clear evidence that plastics degrade with each subsequent pass through the recycling process. Durability fades, microscopic pieces get shaved off, and the items made from the reprocessed material are weaker than they were when they went in.

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Now, some manufacturers have found ingenious ways of repurposing this new and weaker plastic by creating things like fleece or polyester. There is also no denying that by reusing these plastics, we are lessening the need to access more raw materials or create more plastic products.

Many people assume that plastic, like glass or paper, can be recycled over and over again forever without losing any quality. The truth is that the same piece of plastic can only be recycled about 2-3 times before its quality decreases to the point where it can no longer be used. After that, in most cases, it ends up in a landfill, where it slowly breaks down into microplastics and emits methane. Microplastics are microscopic bits of previously produced plastic material that have broken down so much that they almost cannot be seen with the naked eye. Unlike other recyclable materials like paper, glass, or even aluminum, plastic doesn't decompose, biodegrade, or become something else over time. Once it has been turned into plastic, it remains plastic forever (450 -1,000 years to decompose, some argue it will never decompose). It just gets tinier. These dangerous beads of microplastic can become ingested by animals and humans through our water supply. We have known that something was amiss for now, but it is only now that scientists are beginning to understand how much damage they are doing to our food supply, water supply, natural ecosystems, and our bodies.

Therefore pre-cycling and/or designing out plastic is crucial in order to reducing plastic in our environment!

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Below you'll find some **ideas on your way to designing out plastic along your products development process**, and so contributing towards a less wasteful, more environmentally friendly and a less carbon-intensive world:

Design in reusability and recyclability
How will the product be dismantled - can the components be reused and if not, can they be made of a recyclable material? Must they be made of plastic? Is there an alternative? Good design and engineering will help your products last longer.

Work with your supply chain
Try to select suppliers who work with ethically sourced materials.

Avoid single use wherever possible
We need to avoid single-use components wherever possible and that means designing in a responsible way. We should aim to get into the habit of planning for end of life when we are designing products. That might mean not using plastic – although we need to be careful of our consideration of other materials to ensure we're not replacing a single-use plastic item with another material with a high carbon intensity or environmental impact.

Consider product modularity
Product modularity can be very effective if you already have a product range. Intelligent design will take into account your existing products and look to design in common components, manufacturing techniques and resources. This in turn can lower development costs, reduce wastage and resources, save on tooling and spread costs across a product range.

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Clean, simple design

Using multiple coloured plastic components or different surface finishing can add complexity when it comes to end of life reuse or recycling. A simpler approach may not only be better environmentally, often it means the product dates less quickly.

Do not choose the cheapest solution

Plastic can be a fantastic material, it is often low cost and can be used to great effect. However lazy design can lead to poor solutions that break easily and contribute to our 'throwaway' culture.

End users are actively choosing ethical companies over others and showcasing your ethical design and material sourcing in your product marketing can allow for price rises and be a very effective sales tool.

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FINAL ASSESSMENT TASK

TITLE OF THE TASK:

Resource recovery in everyday life

AIM OF THE ACTIVITY:

Implement some resource recovery practices in your everyday life (personal or professional) and promote these in order to inspire the local community for sustainable ways of living.

TIME REQUIRED:

This task requires 14 hours in total.

10 hours to reflect on ideas and ways to implement various resource recovery practices - e.g.: drink filtrated faucet water instead of using multiple water bottles (pre-cycle); bring fabric bags for shopping to prevent the wasteful use of plastic or paper bags; use paper, plant matter, food scraps and other organic materials to create compost, which can fertilize gardens, agricultural fields (recycle); take “waste items” and refurbishing them to work like new, such as electronics, appliances, kitchenware, instruments and more (repair); use materials from plastic bottles/etc to make new shoes/clothing, use reclaimed wood to make quality furniture (upcycle), use waste to create art/etc.

4 hours to summarize the experiences in a video or voicefile (podcast) format

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MATERIALS REQUIRED:

Articles, useful readings and video(s) in Eduzine.
Creative thinking
Mobile phone
Laptop
Text/Voice editing software

FORMAT FOR THE PRESENTATION:

With the help of PowerPoint or Google Slides the learner illustrates which practices were tried.
Optional: Podcast

STEPS TO COMPLETE THE TASK:

- Step 1: Make a list with the ideas (based on Eduzine materials and further readings), about how to put resource recovery into practice in your life? (Tips: buying local, second hand, start composting, re-evaluate your buying habits, see above the ideas)
- Step 2: Start executing these practices and document them on your way. (video, podcast)
- Step 3: After testing some practices choose the one which is the best fit for you and you can commit to it.
- Step 4: Summarize your experiences in a short creative visual format creating a presentation with the material you made during the task.
- Step 5: Reflect on possible resource recovery practices you implemented (or different ones) which may lead to a viable circular business idea in your community.

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OR AN ALTERNATIVE FOR FINAL TASK:

Title of the Task:
Ways of Resource Recovery

Aim of the Activity:
Reflect on and draft ideas for resource recovery (any form of resource recovery such as RRfW, RRR or incineration, etc) ideas, based on the case studies in the above Eduzine as well as based on some desk (&field) research done in the own region to identify companies active in the field of

Time Required:
This task/project requires 32 hours in total.
16 hours desk (and possibly field) research
4 hours to reflect on ideas and ways to implement various resource recovery practices
8 hours design draft ideas
4 hours to present the draft ideas in a video or voicefile (podcast) format

Materials Required:
Articles, useful readings and video(s) in Eduzine.
Creative and critical thinking
internet
Laptop
Text/Voice editing software

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Format for the Presentation:

With the help of PowerPoint, Prezi or Google Slides the learner presents the drafts for potential RR business ideas in the own region.

Optional: Podcast

Steps to Complete the Task:

- Step 1: read about case studies and watch the videos from the Eduzine and additional resources about various ways of RR
- Step 2: do some desk (and if possible field) research in your region/country to identify companies who are active in the field of RR or recycling, continue with some more research about these companies identified
- Step 3: reflect on similar solutions that could be applied in your own region
- Step 4: present your draft ideas in ppt/prezi/google slides

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FINAL TEST

Are you ready to show what you have learned from the Eduzine?

Do you feel you know more about Resource Recovery now than when taking the self-reflection quiz at the beginning? Once you have read all of the articles in the eduzine, you will have no problems completing this quiz.

https://docs.google.com/forms/d/1sRG4Qu3L-6UkYYXUXfztIvywRNPRBGKWQcVT2QWWjS8/edit?urp=gmail_link

FURTHER READING AND RESOURCES

Waste reduction / Green choices
https://www.greenchoices.org/green-living/waste-recycling/waste-reduction

Resources, Recovery and Reuse (RRR) Entrepreneurship
https://wle.cgiar.org/solutions/online-course-resources-recovery-and-reuse-rrr-entrepreneurship

Reducing Waste. What can you do?
https://www.epa.gov/recycle/reducing-waste-what-you-can-do

Waste incineration – recovery of energy and material resources
https://eng.ecoinnovation.dk/media/mst/8051413/Affald_Case_Forbr%C3%A6nding_web_15.01.13.pdf

Shaping the future of resource recovery in Aarhus, Denmark
https://iwa-network.org/shaping-the-future-of-resource-recovery-in-aarhus-denmark/

Skill Circle/ Strategies, benefits and challenges of going circular
https://skillcircle.eu/en/learning-platform/3/13/main-strategies-enterprises-can-use-to-develop-a-circular-business-model

Conservation of natural resources
https://eschooltoday.com/learn/natural-resource-conservation/

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Resource Recovery: Turning Waste into Energy
https://extension.psu.edu/resource-recovery-turning-waste-into-energy

The Circular Economy: What Is a Resource Recovery Model?
https://blog.veolianorthamerica.com/circular-economy-what-is-resource-recovery-model

It's All Downcycled From Here
https://freshkillspark.org/blog/its-all-downcycled-from-here

Recycling Explained! Learn About Upcycling, Downcycling & Pre-Cycling
https://www.youtube.com/watch?v=YjJMTy5noy8

Recycling
https://www.britannica.com/science/recycling

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