Unnecessary – Useful & Aesthetic

Creative approach to recycling

A handbook for optimists.

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Unnecessary – Useful & Aesthetic

Why elaborate a handbook about electric and electronic waste, and how to make new things out of it? Easy answer: because WEEE (waste electric and electronic equipment) is the fastest growing type of waste, worldwide. The natural resources involved to make the gadgets we use daily consume vast amounts of natural resources, some of them very rare. And the extraction of the raw materials happens under often horrible circumstances, both for the people involved, and for the environment.

So raising awareness about these facts is a must. However, most people don't particularly like restrictions of their lifestyle, or insinuations going in that direction. What they might enjoy, instead, is a good bunch of well researched information, explained in an accessible way – and the challenge to create something new, with their own hands, out of that very same e-waste. Upcycling is the new old fashionable trend of using waste materials in a creative way, putting them together so that they form something new, exciting, useful, beautiful…

Come and dive into the following pages, where you will learn exactly the content mentioned above:

- What is inside old (and new) electronics?
- How can you instigate climate friendly behaviour, by giving inspiring workshops for all kinds of audiences, also socially marginalised?
- Where do you find appropriate appliances, and what do you need to dismantle them?
- What can your workshop participants make out of old cables, a piece of printed wiring board, a CD…?

Examples from workshops already held by this EU project's partner institutions can give you some more inspiration about how to use different materials and techniques.

Good luck – and have fun!

Content

Sustainable use of mineral raw materials

Angelika Brechelmacher, ARGE grenzen erzählen

Mineral raw materials are essential for the production of a broad range of goods and applications used in everyday life. Let's think of electronic data carriers, batteries, cell phones, laptops to name just a few of technologies of our daily use. Tungsten is essential for cell phones. Gallium and indium are required for light emitting diode (LED) technology in lamps. Hydrogen fuel cells and electrolysers require platinum group metals.[i] The industrial demand for mineral raw materials in Europe is high. In contrast, recoverable mineral deposits are distributed very differently across the continents. How we deal with these limited, non-renewable resources determines the future of the coming generations of all living beings on our planet.

Figure 1: Transforming our world – The United Nation's Agenda for 2030

In September 2015, the 193 member states of the United Nations adopted the agenda "Transforming our world: the 2030 Agenda for Sustainable Development", which defines 17 Sustainable Development Goals (SDG).[ii] The SDGs represent a global action plan for social solidarity to end poverty, environmental sustainability and economic development.

The EU is committed to these goals. In its 2016 Communication "Steps towards a sustainable European future", the European Commission (EC) committed to applying the principles of sustainable development to all EU policies and initiatives.

The European Commission's Raw Materials Initiative

Bottlenecks in the supply of raw materials and high prices caused by the economic crisis in 2008 prompted the EC to initiate studies how to make Europe more independent and autonomous from markets in conflict-affected and high-risk areas and to start the so-called "Raw Materials Initiative - meeting our critical needs for growth and jobs in Europe"[iii]. This strategy is based on three pillars:

1. Fair and sustainable supply of primary raw materials from global markets;

2. Sustainable extraction of raw materials from European mining;

3. Circular Economy - resource efficiency and provision of recycled raw materials.

1. Critical raw materials from global markets

Many essential raw materials used in technologies are not exploited in Europe, but imported from China, Russia, South America and other parts of the world. Mineral raw materials imported to Europe that are subject to supply risks, and for which there are no easy substitutes are called critical raw materials (CRM). In 2020, the list of critical raw materials[iv] contained 30 elements. Even so-called green technologies, intended to steer energy consumption in a sustainable and resource-saving direction, ultimately are dependent on CRM. Lithium e.g., essential for a shift to e-mobility, is part of the list of CRM. Alternative energy sources such as wind turbines or solar panels, require large quantities of iron ore from Brazil, copper from Peru and Chile, silver from Mexico and Argentina, bauxite from Guinea and rare earth elements from China.

2. Increase in raw material extraction in Europe

In a press release from September 2020, Thierry Breton, Commissioner for Internal Market said: "We cannot afford to rely entirely on third countries – for some rare earths even on just one country [China]. By diversifying the supply from third countries and developing the EU's own capacity for extraction, processing, recycling, refining and separation of rare earths, we can become more resilient and sustainable. Implementing the actions that we propose today will require a concerted effort by industry, civil society, regions and Member States. We encourage the latter to include investments into critical raw materials into their national recovery plans."[v]

Subsequently, European research programs provide significant funding for the development of optimized technologies to make mining in Europe more attractive to mining investors. Research projects focus, for example, to minimize dust and emissions in order to increase the social acceptance and ecological compatibility of mining in inhabited areas. On the other hand, technical universities and mining companies are testing new extraction methods that separate usable minerals from waste as economically efficient and environmentally friendly as possible.

However, EC and EP are increasingly focusing on the third pillar of the Raw Materials Initiative, the circular economy.[vi]

3. On the way to a European circular economy

In March 2020, the EC presented the Circular Economy Action Plan[vii], which aims to encourage more sustainable product design, to reduce waste and empower consumers by legally establishing their right to have goods repaired.

The European Union produces more than 2.5 billion tonnes of waste every year. It is currently updating its waste management legislation to encourage the transition to the more sustainable circular economy model.

In February 2021, the European Parliament passed a resolution on the new Circular Economy Action Plan as a production and consumption model in which existing materials and products are shared, leased, reused, repaired, refurbished and recycled for as long as possible. In this way, the life cycle of products is extended. The Circular Economy Action Plan's aim is to achieve a zero-carbon, green, non-toxic and fully circular economy by 2050, including stricter recycling rules by 2030.

Figure 2: Circular Economy, source: European Parliament[viii]

In practice, this means reducing waste to a minimum. When a product reaches the end of its life, its materials are kept in economy whenever possible. These can be used productively again and again and thus create additional values.

The challenge: 5,500 Eiffel Towers …

… in just one year! This is what the *UN Global E-Waste Monitor 2020* came up with: in 2019, unimaginable 53.6 million metric tons of electric and electronic appliances were disposed of as waste, worldwide. This amount corresponds to the above mentioned mass of Eiffel Towers. Beyond that, it's the fastest growing type of domestic waste – at a rate of 21 % up in just five years.

Europe alone generates 12 Mt yearly, 16.2 kg per person. Could you guess that each European owns, in average, 250 kg of electric appliances?

And why is this a problem? The production of electric and electronic equipment consumes a vast number of material resources: just to give you an example, one single notebook takes eight tons of raw material (minerals containing copper, aluminium, iron, gold, silver, platinum and rare earths), and 30,000 litres of water in the making. And then, it might only be in use for a short couple of years. What a waste of valuable natural resources!

Worldwide, only an average of 17 % of all WEEE is recycled properly, 42.5% in Europe. According to the *EU Waste Framework Directive*, what you really should do is: *refuse* (to buy new products in the first place, wherever possible), *re-use* (already used products, e.g. buy second hand, trade within the family…), *repair* (instead of buying new), *recycle* (if it's definitely not re-useable and repairable), so that *recovery* of materials can take place, and only the last resort is *disposal* (of whatever is left after recycling).

Unfortunately, WEEE does not only contain valuable resources, but also hazardous substances which should not poison living beings or pollute the environment: e.g. batteries, capacitors and lamps of all kinds. Their proper treatment is tricky, but absolutely necessary.

Circular thinking and acting, towards a circular economy, is the urgent next step to minimise waste, taking advantage of existing resources, and creating green jobs. Apart from politics and business, also education is part of this transformation, to gradually create a whole new culture.

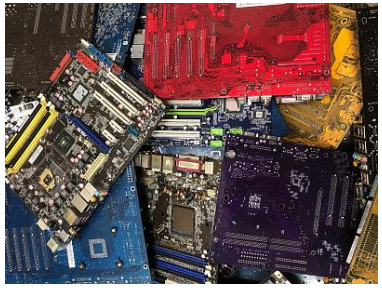
Design for circularity diagram (RSA 2013, p.34) Reproduced with permission from the RSA

Upcycling has proven to be a good communication vehicle to spread the word about over-consumption, resource management and creative inventiveness, imagining and actually making new things from old stuff. What would YOU come up with, if you got some special materials?

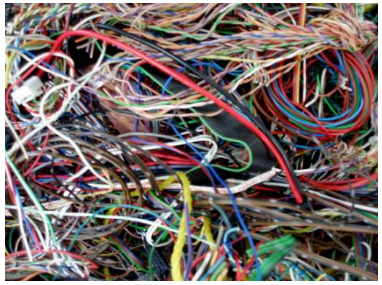
Pretty waste – and what to make out of it

Not all e-waste is appealing. But some parts of it, once dismantled and cleaned, can become really nice design products.

A regular old computer, taken apart until only the casing is left. By then, you will have taken out all drives, like CD, DVD or floppy disk drives, the hard disk drive, the power supply, and the motherboard, equipped with a variety of elements, such as graphic or sound cards, a button-cell battery, aluminium heat sink with a fan upon the CPU or processor, capacitors of all sizes… The metal or plastic case can be cut into pieces and connected with bookbinding linen. Adding a ring binding mechanism, you get a fancy and durable notebook.



Graphic or video cards from PCs, dismantled as mentioned above, make nice desktop clocks. What you need to do is mount the printed circuit board onto an aluminium heat sink which serves as a base or foot, and add a commercial clockwork (on the back) and pointers on the front.
Completely depleted circuit boards can become notebooks, or jewellery…



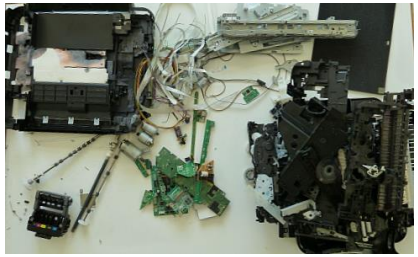
Cables and wires, in all dimensions and different colours: what would you think can be made out of them? Here, the thin coloured wires from the inside of an old printer cable were combined to become a matching necklace and bracelet, and pieces of printed circuit board turn up again as rings and earrings.

Dismantling a whole washing machine is not the easiest task, but it's feasible, with the right tools and some effort. The drum, made out of stainless steel, needs some thorough cleaning, before becoming a new and shiny piece of furniture. And the bull's eye of a front loader washing machine, which consists of heat resistant borosilicate glass, can gain a new life as a decorative fruit or salad bowl, after cleaning, and sandblasting whatever design you decided to plot out from the computer.

What you need

Waste electric or electronic equipment

Depending on what you want to “harvest” in terms of materials, choose the appliances that you try to get. Computers sure offer the most interesting elements inside, with all different kinds of colours and structures, from the outer shell or case, to lots of wires, and printed circuit boards.



Not all devices are equally easy (or difficult) to dismantle: those with a tightly glued case can be too difficult to open, you might prefer those with screws holding the parts together (sometimes, they can be hidden under stickers…!). And not everything contains really interesting parts. Printers, a perfect example for planned obsolescence (which means: made to break soon, and become obsolete, so you have to buy a new one), basically consist of a huge number of different plastic parts (cover and casing, gear wheels, bits and pieces…), some metal elements, and a green printed circuit board.

Keep off!

There are appliances which contain elements that can be hazardous for human health and/or the environment. These can only be recycled at specific facilities. Never open or dismantle any of the following:

- **Cooling or freezing appliances**
  They contain cooling agent, oil and gas. The only parts you can remove manually are the power cable, and the inner shelves of fridges and freezers.

- **Screens and monitors**
  The backlighting might contain harmful substances. You can dismantle the lower part of a laptop, and disconnect the screen.

Where will you get your e-waste?

In order to get old, used and no longer needed electric equipment, you can of course simply ask around in your family, your workplace, or any other situation that gives you access to people. But when you need a certain quantity, so you can have a workshop for a group of participants, it's recommended to get in touch with:

a) Your local collection site

Find out if your municipality does collect e-waste separately (it actually should!). Explain that you need a certain amount of equipment, just to borrow it, for educational purposes, and that you will bring back all material that will be left after the workshop is done.

b) E-waste recycler

If your region has sourced out the collection to a professional e-waste recycler, find out who that is, and again explain that you need appliances for educational reasons. Don't get overwhelmed by the masses of stuff! Think about how many electric devices you use (or own) in your home and at your workplace: is it 20? More? So, no wonder….

c) The community

Why not make a call for collection at your organisation? This is the way to go if you want to make the e-waste matter a major program element at your institution: make a call into the local community, to drop by and bring along old electric appliances (again: no fridges, no screens!). If necessary, specify, which equipment particularly interesting for the workshop.

In return, offer general information about natural resources, raw materials, and the role of e-waste in all that. If you include the public in the dismantling process, In the workshop, they can then discover what is inside their own former favourite device – and make something new out of the parts!

Please make sure you hand over the remaining parts, bits and pieces to the right place after dismantling and using some of them for upcycling: your municipal waste collection and separation site, or a professional recycler.

Infrastructure

Of course it would be ideal if you had a fully equipped workshop, with all common tools, devices and machines, to work away with materials like metal, printed circuit boards, or cables. Tools included would be:

- electric, battery-driven screwdrivers with different bits, also very tiny ones (mini bits)
- a single-hand angle grinder with cuttings discs (for cutting metals) and scrubbing discs (for grinding)
- a table drill fit for up to 13 mm drills
- cutting devices, such as table shears
- metal sheers, riveting pliers
- files and sandpaper with different textures (for deburring or smoothing sharp edges after cutting)

If you don't have a workshop like that, maybe you can use one at a nearby school, or adult education institution? Or borrow some equipment from a "tools library", or a swap platform? Sharing equipment is also good for the environment: if several people use one and the same tool, less resources are necessary for the production of new ones!

What you really, absolutely need:

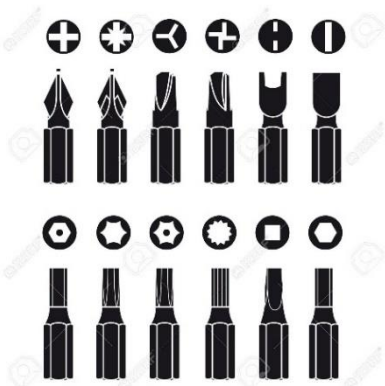
- Sturdy work desks with surface protection. You can also cover ordinary desks with cardboard, just so the surface doesn't get scratched.
- Sufficient lighting so you can see even very small screws.
- Safety equipment:
  - Gloves, goggles, dust mask
  - clothes that may get dirty, or an apron for protection
- Tools for dismantling
  - Different kinds of screwdrivers or a handle with different blades; a set of mini bits for very delicate screws. Look closely at your screws, and always use the right shape or type, and always the largest size possible, in order to avoid getting hurt
  - Hammer
  - Tweezers, side cutter, shears, cutter
- Containers for the dismantled fractions.

Always keep your workshop clean, and your tools in shape!

Dismantling instructions

First of all, you might wonder: are there any dangers involved in opening and dismantling electric or electronic appliances? It depends: please leave screens and cooling equipment aside, those are for professionals! Also, don't open lamps or batteries, or any medical equipment, for that matter. Look out for "easy stuff": household appliances, old hi-fi equipment, computers… Again: try to watch out for casings that are screwed together, maybe clipped. We don't recommend glued casings, as they are difficult to dismantle without using rather violent hammer blows. This new way of looking at electric devices will also give you a first impression of how easy or difficult it would be to open and repair any of these.

Use the correct tool to open and dismantle any appliance, always wear gloves to protect your hands from cuts – and watch carefully for the "logics" of the construction: how the device is put together, in which order you should tackle different parts, etc. There is no overall instruction valid for any kind of appliance: there are just too many types, models and brands, and each might be constructed in a different way.



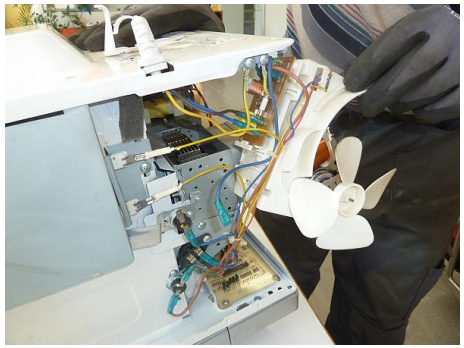
Obviously, you will work from the outside to the inside. Always make sure that the device is disconnected from electric power before you open the casing, to reach the interior. Probably, you will see a bunch of different elements now, connected by cables and wires – and possibly, a great amount of dirt and dust. If necessary, wear a dust mask. Follow the wires and disconnect them, either by just pulling, respectively releasing click-on plugs, or by cutting them with a side cutter. Search for more screws, again using the right bit to loosen them, that is: always the largest possible dimension that fits tightly, of the right kind of head (Slotted, Phillips, Pozidrive, Torx…).

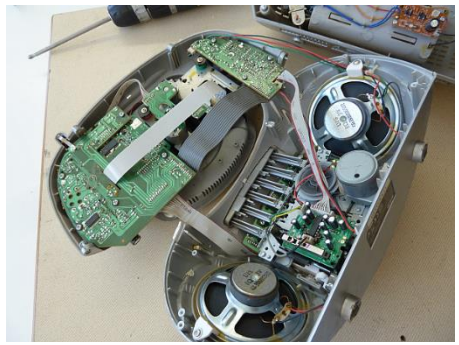
Step-by-step

Step 1: cut the power cable of the appliance – and/or remove batteries.

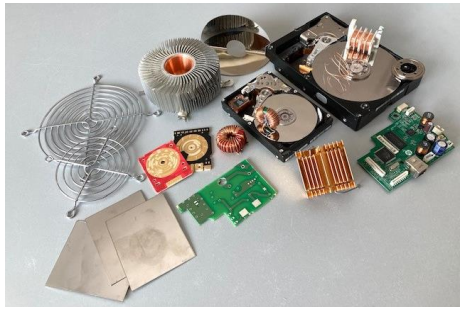
Step 2: unscrew all screws you find around the case in order to open it.

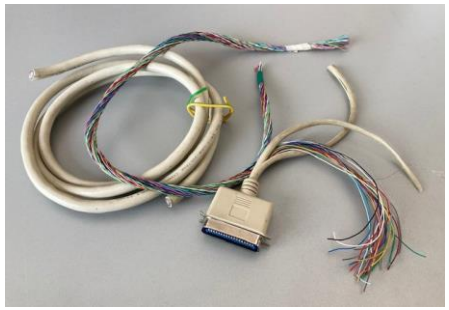
Step 3: Remove internal parts by disconnecting or cutting cables.



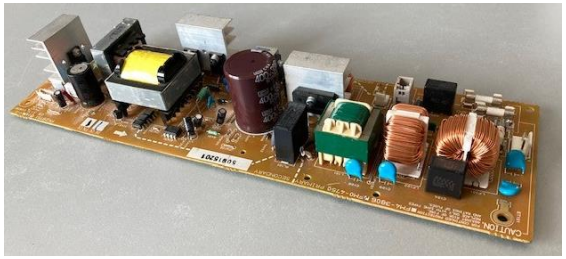


Step 4: Separate those materials you want to use for creative upcycling.





How to dismantle printed circuit boards

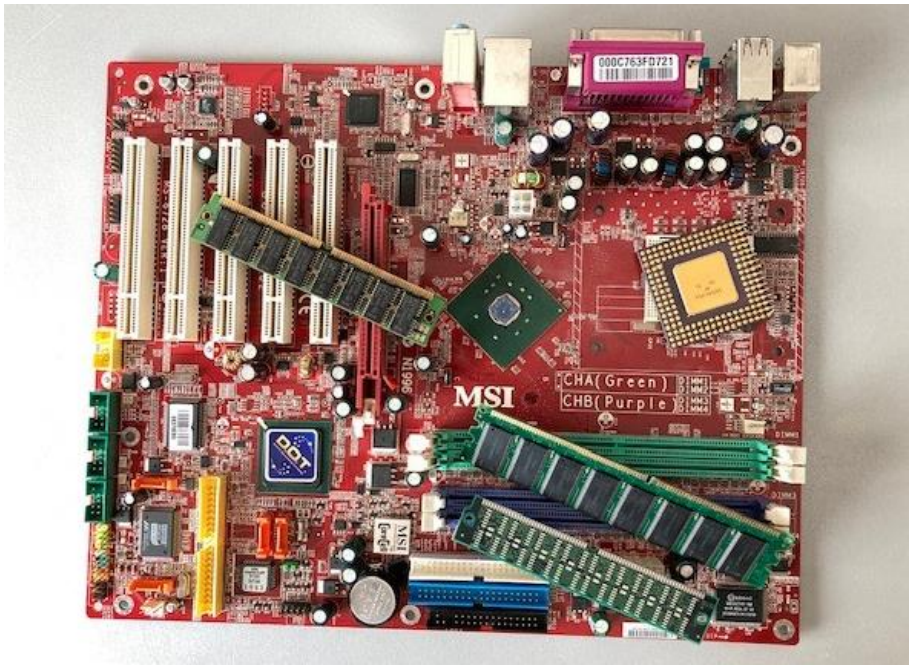


Printed circuit boards (PCB) consist of fibreglass reinforced epoxy resin layers that contain the connections between components. That's what appears like the design of a strange city map. They are made of partially very valuable materials, such as gold, silver, palladium etc., and on the other hand also contain harmful substances, like lead. But no worry: there no danger involved if you follow the instructions here, and in the next chapter.

If you want to use a PCB for a crafts project, first of all remove all hazardous elements: the CMOS battery from computer main boards (the coin-sized flat battery that "remembers" e.g. date and time), large capacitors, and accumulators (can contain heavy metals such as Cadmium).

Capacitors thicker than a finger might contain electrolytic liquid that is bad for your health and the environment, so avoid leaking.

Always wear protective gloves in order to avoid hurting yourself. Remove by turning gently and pulling, without damaging or destroying the capacitor. Dispose of as hazardous waste.



Some components can be taken off quite easily: RAM memories on a PC main board are clipped into their slots, and you just need to press down the clips on either side to release them. These show golden (or silver) contacts. The CPU (central processing unit, the "brain" of a computer) is a part that fits in your palm and presents a dense grid of tiny, thin golden pins.

Remove further parts that can be taken off with hand tools (use a larger screwdriver as a lever to pry off).

If you want a completely depleted board, of all soldered components, you need to put the entire PCB on a metal grid (like from an oven or grill), and heat it over 230°C with a 1000 W hot air gun and then knock it gently against a piece of wood. Now, all parts should fall off, since the heat unsolders the tin-silver-alloy connections.

Dismantling hard disk drives

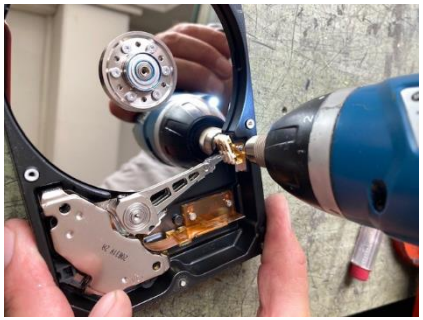
Hard disc drives are the compact, rather heavy pieces shown below, which in their interior carry the data of a computer on several thin discs, held parallel to each other by aluminium distance rings and then fastened with very tiny screws and an end ring. Inside the casing, you also find the data reading unit and an extremely strong neodymium magnet.

To get to the interesting materials inside a hard disc drive, e.g. the shiny data carrier discs, smaller distance rings and end ring, you go by the following steps:

Open the HDD casing by unscrewing, by hand or with an electric screwdriver. Most probably you will find very small screws in the corners holding it together that require a N° 9 Torx bit.

Attention: some screws might be hidden under stickers! Find and uncover them by scratching with a small screwdriver, then unscrew.

Flip the casing open by removing the lid you just unscrewed. Now, you can see the interior of the HDD with the data carrier discs and the remaining elements.



Unscrew the data reading arm.

Here, in the lower left corner, you see the strong magnet.

Unscrew the screws that hold together the data carrier discs and the end ring with the tiny holes.

Now you can remove the end ring, in order to access the shiny data carrier discs and the distance rings between them.

Finally, you can now separate all parts, and use them as you like!

Please separate and don't use!

The following components are considered hazardous, must therefore be removed with caution, and should never be opened, destroyed, or put in the residual waste bin, by any means!

All these should, consequently, never be used as material in a workshop, but separated, and handed over to an appropriate recycler.

Batteries in general

Button cell batteries

Li-ion batteries (extremely powerful rechargeable batteries, in relation to their size, which we all carry around in our smartphones, but are also used in an increasing number of other devices) are particularly sensitive. If not handled with caution, they can catch fire or even explode, so never drop, destroy, bend or ignite! Insulate the contacts with tape and store safely until disposal, that is, taking to the right place for recycling.

Below:
Example of a lithium-ion battery that caught fire.

Capacitors have already been mentioned when dismantling printed circuit boards, where you find the smaller ones. In large equipment (washing machines, or dishwashers), they are much larger, like the ones on the left, with aluminium cover.

Printer cartridges from either ink-jet or laser printers not only leave coloured traces on your hands, they also contain pollutants, so don't throw them in the bin! Best: take them to where they can be refilled.

LCD screens can be found in almost every electronic appliance.

Lamps such as energy saving or fluorescent ones break easily, and might contain harmful gas (mercury!), so treat them with uttermost care.

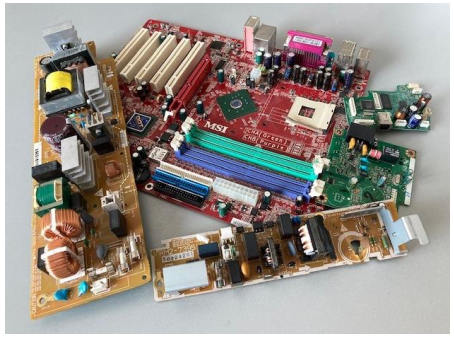
Useful materials after dismantling

Take a closer look at what you got now: pieces of different materials, textures, shapes and colours. Play with them and combine!

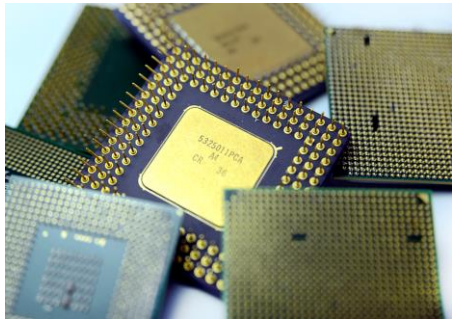
The most common and useful materials are:

Cables and wires: power cables, internal wiring, and the coloured thin wires found inside of some thick printer cables, when cut open lengthwise

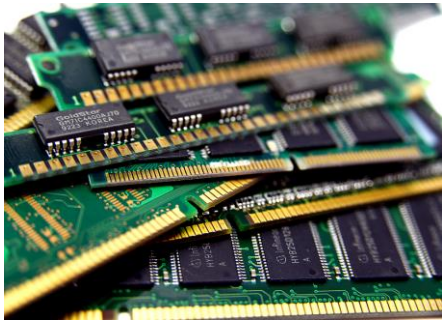

Printed circuit boards in different colours and dimensions



CPU (computer processors)



RAM memory



Iron metal: microwave or PC casings, screws, nuts and bolts, metal springs


Stainless steel: washing machine drums (structured, punctured surface) or clothes driers drums (smooth and closed surface)


Plastic parts of all colours and kinds


Aluminium heat sinks

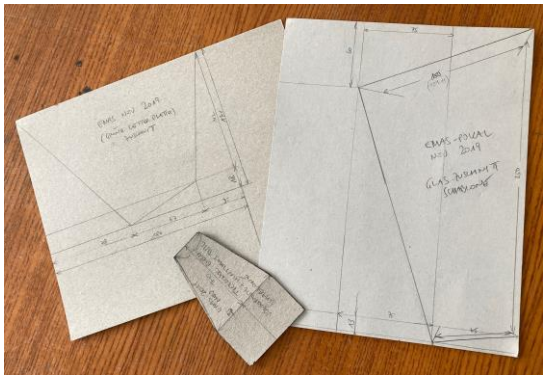
Copper (from unwound coils)

How to…

In the following chapter, you will receive very concrete and practical instructions about how to “invent” an upcycling project and finally realise a workshop for your target group.

1) … develop a workshop

1. **Check your possibilities** (and limitations)
   Make sure you take a thorough inventory of available material, space, tools and skills. Who is able to apply which tools, technologies or working methods? Recommended, ideally, but probably not always available is a basic workshop equipment such as described above under “Infrastructure”.
2. **A brilliant idea**
   Your inspiration about what you would like to make out of e-waste material accessible for you (with help from this handbook, other literature or maybe the internet – Pinterest, YouTube or Instagram offer great examples!). It should be simple, and feasible: easy to make, sure to be finished in the time span foreseen, with a satisfactory result.
3. **Trial and error**
   By all means, please try out what you would like to do in a workshop, before you do it later with a group of people. If you want to assist them, and make them have a good and positive experience, you should be able yourself to accomplish the task! By repeating the procedure, you will realise what challenges your participants might meet, and how to overcome them. Document any sidesteps from the original path, by correcting measurements, taking notes or making a sketch of what works, and what doesn’t.
4. **Make a plan**
   Develop a goal that is feasible, reachable, for the target group, with the available infrastructure and means. Who will participate? How many people? What will you need in terms of e-waste material? Where will you source it, who will dismantle it? What about protection equipment, tools and additional materials to be purchased, such as paint, glue, screws, cable binders, special drills…: is there a budget for these? Where do you get them, and when?
5. **Prepare**
   From an initial draft, which can be a pencil sketch on paper, or a model out of paper, proceed to a plan, which includes the necessary measurements and technical details.



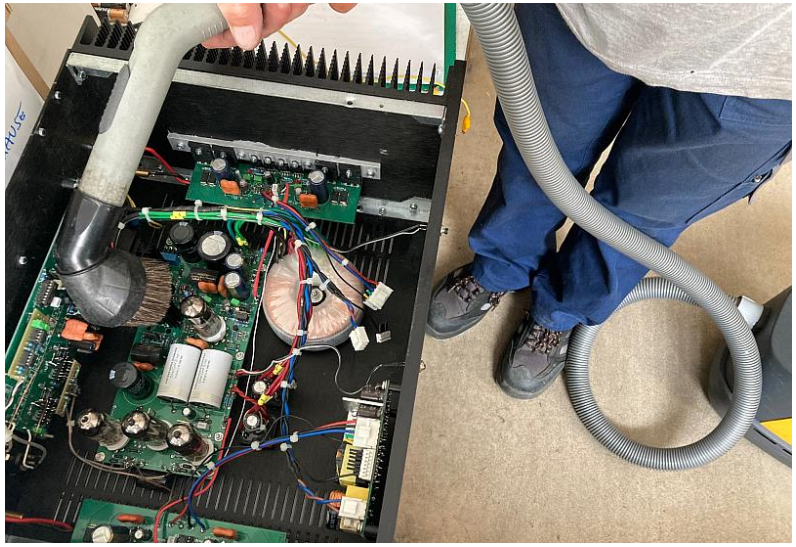
For some projects, you might want to prepare adequate facilities or technical equipment, in order to make your life easier when making a larger number of a similar or the same product. Make sure you know the right order of all work steps to take. But also consider breaks and relaxation phases for your workshop participants!

6. **Take safety precautions**
   Whatever material you choose to work with, make sure you are familiar with safety issues involved (skin or eye contact with chemical substances – and what to do in case this happens), and keep the necessary equipment close at hand: a bucket with cold water when working with the hot glue gun, a first aid kit for cuts and bruises…
7. **Follow-up**
   Keep your tools in shape, your space tidy, and always clean up properly after work! That helps a lot when starting the next time.
8. **Documentation**
   You might want to take some notes about your workshop: what was a success, what less so, what was difficult, where were the challenges, and how could you overcome them next time? Perhaps you want to send some pictures to your participants, which show them busy at work?

Now let's start work, hands on! Here, you will learn about different methods, in detail, how to handle and process your e-waste parts, step by step. How to …

2) … clean parts

1. **Mechanically**: with a vacuum cleaner, blowing with compressed air, or using a brush



2. **Using water and soap**: if the material will stand that treatment without damage.

3. **With chemicals**: Whenever water and soap are not enough, use all-purpose cleaner, standard glass or window cleaner, petrol or spirit (for greasy dirt).

> **Attention**: Acetone (like nail polish remover) or nitro diluent are not recommended, because they are neither healthy, nor effective!

In the case of washing machine drums, usually the interior is rather clean, because the clothes inside in a way keep swiping and polishing the surface when the drum turns during the washing process.

On the exterior, however, drums after dismantling can be quite filthy: lime and grime cover the structured surface. Here, the best way to go without spoiling the surface is to spray with a mixture of water, citric acid and very little of a descaler for appliances (which contains small amounts of phosphoric acid), let it sit for 15 minutes, and then wash off with pure water. No rubbing and scrubbing, only use a nylon brush (toothbrush, hand or dish washing brush) or a soft cloth. The result is shiny stainless steel!

To clean dirty aluminium heat sinks, first remove all traces of glue mechanically, that is: scraping with a spatula or screwdriver. Conductive (white) paste you can simply wipe or rub off with a piece of tissue or cloth. To get into all the hardly accessible cavities, spray with an ecologic universal cleaner on capillary base, suited for most surfaces, except glass: it lifts off dirt so you can easily rinse it off with water.

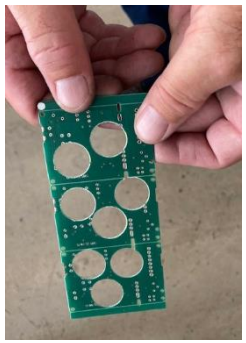
Now that you have clean parts, the next step is preparing them for processing: remember to make a project plan first, so you know which parts you will need, take exact measurements, and mark precisely what you want to process.

3) … process mechanically

In order to create something new from now cleaned parts, you will most probably have to change their shape to fit your plans. Here, you find the most common methods: Cutting pieces to size and format, punch holes to get round pieces, drill holes to screw or rivet together later (see next page), and

Cut metals with appropriate manual shears… or guillotine shears.

Cut pieces of printed circuit board with a metal saw. Manual sawing creates dust particles large and heavy enough to fall to the ground instead of getting into your lungs. Never use a machine saw, though, sawing dry! This causes minuscule particles containing harmful substances to pollute your respiratory system.



For perfectly round holes or coin-sized pieces of material, you need a hole punch.

Drill: In order to drill a hole, get the right bits for the chosen material (HSS metal drills for both metals and printed circuit boards), and watch the rotation speed. A standing drill on a drill bench is of great help!

Trim and deburr the edges after cutting. This means removing excessive and potentially sharp material that could hurt you, by smoothing the edges. With small parts, it's easier fastening the piece in a vice, or at least with a clamp onto the work surface.

After drilling a hole, use a slightly larger drill to deburr the hole's borders by turning gently, manually.

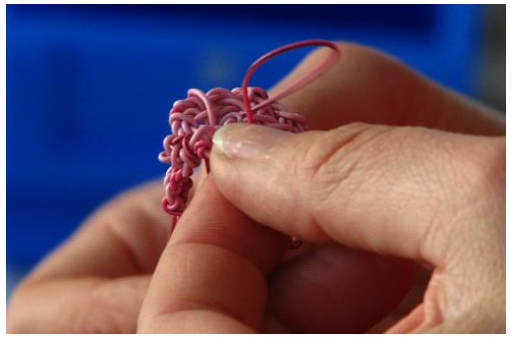
Remodel by bending Before bending a hard disk, please test with a metal detector if its core is made of aluminium or ceramic material, as you can only bend those with a metal core.

4) … connect parts

There are different kinds of connecting techniques when it comes to join parts, perhaps of differing materials. Here, you see some basic methods:

Tie together, twist, braid, weave, sew, plait, lace…

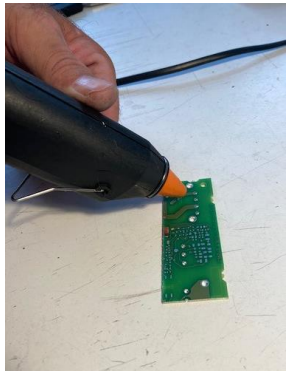
If you choose to work with cables and wires, look at some inspiration from the project partners, e.g. easy weaving (Portugal and Croatia), and macramé (Sweden), or connecting with cable ties (Italy).



Glue together

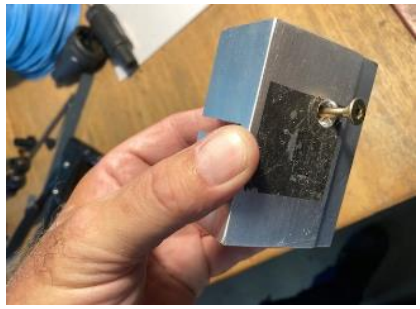
A hot glue gun with the respective glue sticks is one of the most versatile and cheap helpful tools that you might want to get. You can achieve long lasting connections, if you clean the parts that you want to glue together thoroughly beforehand, and free them from all dust and grease. Always apply the glue to the part with less heat conductivity, e.g. to the printed circuit board instead of the metal piece. Using a hot air gun, you can soften the hot melt glue again and adjust the position of the second part.

Other types of glue are contact glue or two-component glue.



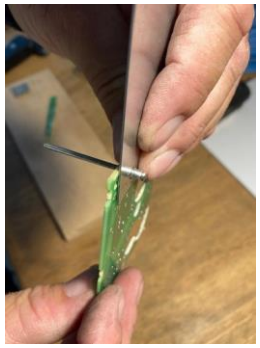
Screw together

Sometimes, electronic parts already contain holes that you can easily use for screwing pieces together. Or else, you have to drill a hole, as shown before, and you need appropriate screws or nuts and bolts.



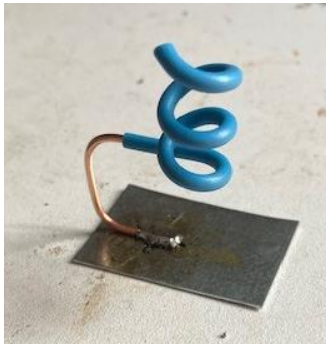
Rivet

Another form of connecting that requires holes in the materials that you want to join, plus riveting pliers and rivets. Note that riveted connections cannot be separated.



Soldering

This method is suitable for metals such as copper, brass, bronze, nickel, iron, silver or gold, and basically means to glue with liquid metal. You need a soldering rod, soldering tin, conductive paste – and a quiet hand.



Welding

Welding metal parts requires a rather advanced equipment: a welding unit (inert gas welder, e.g. for stainless steel, or manual arc welder), plus the necessary protection equipment, and a properly ventilated workshop space. Given the fact that you will be handling up to 4,000°C, it is obvious that you have to fasten the pieces you want to connect without ever touching them when welding. Use clamps! Always wear the appropriate safety shield mask, as the light emitted can badly harm your eyesight!

Spot welding requires yet another device, which heats copper electrodes up to 2000°C for fractions of a second. The materials to be connected melt slightly on this very spot and form a steady connection, without any additives or additional materials required. The result is an almost invisible elegant connection – through a tiny spot.

5) … treat and finish surfaces

Finally, you might want to change the appearance of the surfaces of the materials you chose for your new product, and give them a different look. This is basically possible by treating the surface itself mechanically, in order to change its structure and look, or by applying a coating of a different substance, e.g. paint.

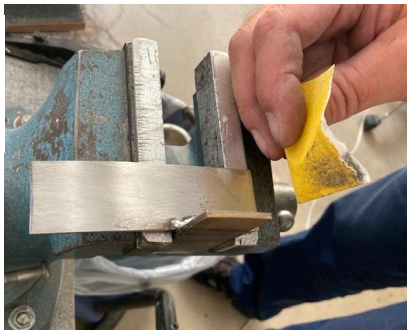
Brush or file

A metal brush is great at removing remnants of rust or paint that you want to get rid of. Rough surfaces can be smoothed by brushing with a metal brush, or, or on the contrary, you can use it for giving a smooth surface some structure.

Filing with a metal file smoothens sharp edges. It is also used to work on unattractive, thick welding seams, to improve their appearance.

Sand or Polish

For already smooth surfaces, you can apply sanding paper, to make it even smoother…



…or sanding pads (which contain corundum particles) to make them shine.

Undercoat or prime, paint or coat

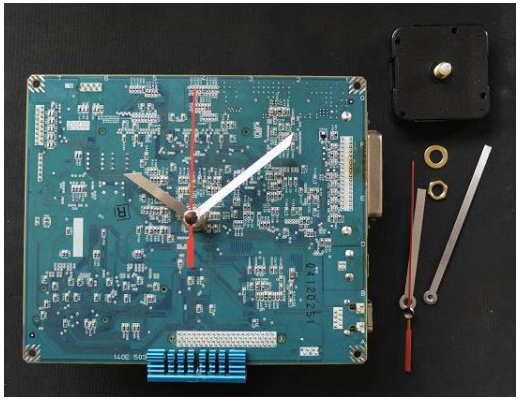
In case you would like to change the colour of any piece, some paint coating will do the job. Avoid spray paint, as it's not healthy to use indoors. Rather roll or brush on your paint. Clean the surface thoroughly first. Then, apply a primer, which helps the paint to merge with the surface of the object you want to colour. Use water based paint, and always wash your rolls and brushes clean after use!

trash_design example 1

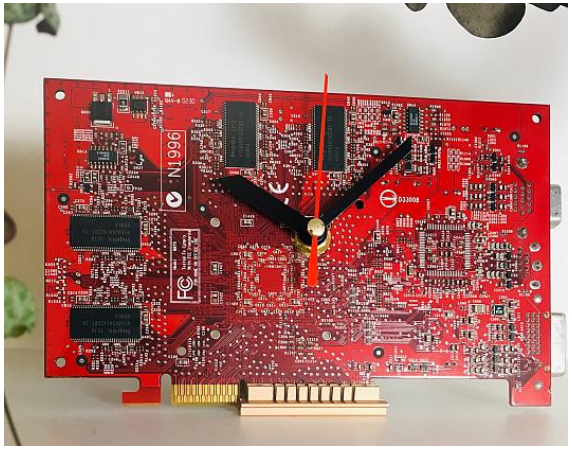
trash_design is part of DRZ (Dismantling and Recycling Center Vienna, Austria) and offers exclusive upcycling products made from chosen components and materials of waste electric and electronic equipment. (See www.trashdesign.at) Here, we show some examples.

Products out of printed circuit boards

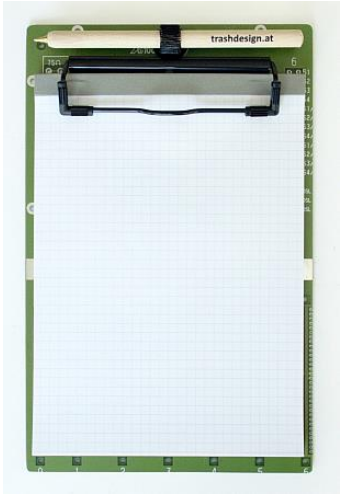
Printed circuit boards, particularly those from computers, show interesting dense electronic patterns, and they come in a beautiful variety of colours: green (which most people know), but also red, yellow, orange, blue, black, brown…

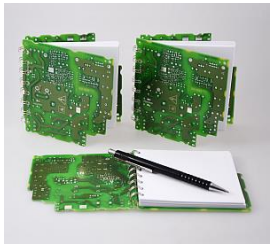


At the trash_design workshop, we transform PC motherboards into wall clocks, and the smaller graphic or sound cards into desk clocks. The foot is an aluminium heat sink. Only the clockwork and the hands are purchased new, externally, and added to the upcycling materials.

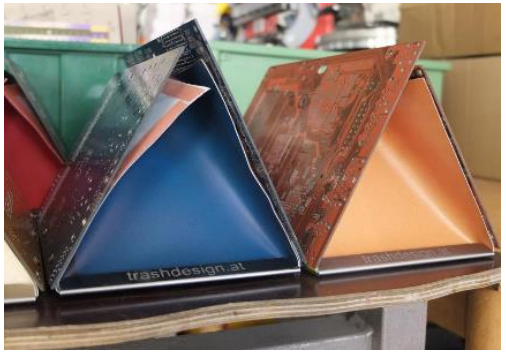


Smaller pieces can be incorporated in jewellery: pendants or necklaces, earrings and rings.





Completely depleted printed circuit boards become notebooks, key rings, Christmas decoration, or even handbags.



trash_design example 2

Cables and wires

Thin coloured wires can be found when cutting open thick printer or monitor cables, lengthwise. These can be combined to beautiful necklaces and bracelets.
Tiny pieces of these wires still make a nice pattern under a coat of clear transparent resin!

Thicker cables, even with different plugs on, form fancy key chains.

Upcycling workshops by EU partner institutions

The project “Unnecessary – useful and aesthetic. Creative approach to recycling” was initiated in 2019, with the main goal to investigate possibilities of communicating the importance of handling used electric and electronic equipment in the correct way, in order to support a transition to a sustainable circular economy. Since repair for re-use requires trained and skilled workforce, the chosen approach was a creative and playful one, showing adult educators ways and means how to make upcycling projects out of materials coming from dismantled e-waste.

Seven institutions from six different European countries were involved in the process of developing both trial workshops and a handbook that is meant to inspire and support future workshops with target groups at the partners’ national locations. Seven very diverse institutions, with expertise in very different fields, but with the curiosity to learn new approaches as a factor in common, new learnings that can in turn enrich the experience of the communities served in each case.

The time for the project was not the easiest: starting with a kick-off meeting in Vienna in February 2020, to get to know each other, the Covid pandemic restrictions that followed only a few weeks later brought all activities to a halt – for a pretty long time. Despite all difficulties, transnational meetings were held, and workshops were organised.

The project lead and coordination was in the hands of Ośrodek Sztuki, Miejska Strefa Kultury w Łodzi (Community Center for Arts and Culture), Lodz, Poland. Here, participatory projects take place, bridging the gap between the arts and the local community, applying different art forms for educational purposes with adults and youth.

As a social enterprise that processes six tons of used electric and electronic appliances per workday, giving long-term unemployed people a new job opportunity, the Dismantling and Recycling Center Vienna was in charge of editing the handbook. Demontage- und Recycling-Zentrum is part of Die Wiener Volkshochschulen GmbH, the largest adult education institution in Europe, with 42 branches distributed over the whole city of Vienna, Austria.

ARGE grenzen erzaehlen, also from Austria, contributed the opening chapter about critical scarce raw materials, as well as the final sub-chapter about a practical workshop which did not use e-waste as base material, but still results in a product that helps saving aluminium and plastics, both very common in electric appliances.

Further partners were, in alphabetical order:

ADCL – Associação para o Desenvolvimento das Comunidades Locais (Association for the Development of Local Communities), Guimarães, Portugal, is an initiative that supports local communities in their social and cultural development, with the aim of improving people’s lives in a sustainable way.

CIAPE – Centro Italiano per l'Apprendimento Permanente (Italian Permanent Learning Centre), Rome, Italy, aims at facilitating life-long learning, providing adequate didactic support to both individuals and enterprises in their aspirations to acquire key competences for the labour market of the present and the future.

MIGK – Muzeji i galerije Konavala (Museum and Galleries of Konavle), Konavle, Croatia, situated in the very southeast of the country, near Dubrovnik, works in preserving and keeping alive the culture and traditions of the region, staying close to the local people, reflecting their colourful history.

Norrköpings stadsmuseum (Norrköping City Museum), Norrköping, Sweden, finds itself in an old factory district, reflecting the community’s history as second largest city of the country, renowned for its record as “Manchester of the North”. From archaeology to contemporary arts and culture, cultural heritage is displayed and put out for discussion to all generations.

On the following pages, you will find these project partners’ contributions, showing different approaches to upcycling with materials from e-waste.

Participants of the March 2022 upcycling workshop at the trash_design premises in Vienna, proudly presenting different products just finished after learning some of the techniques applied here: key rings from cables with plugs, printed circuit board desk clocks, and containers out of five floppy discs.

by Alexandrina Ribeiro, ADCL - Association for the Development of Local Communities

Tapestry

Giving new life to e-waste through weaving

Workshop duration: 3 h

Instructor: Ana Miguel Henriques, 19 years old, from Porto, university student of Design in ESAD. She studied at Soares dos Reis Artistic Secondary School and took Artistic production specializing in textiles, hence her love for tapestry! She learned several textile areas but as she did training in the context of working with a tapestry artist, Vanessa Barragão, the passion grew even more.

Participants: 10 to 12 adult educators / staff working with people from communities at risk of exclusion.

Summary Description of the Activity:
The way in which we produce, consume, and dispose of e-waste is unsustainable. The workshop wants to make trainees aware of the impact of e-waste on the planet and the way we look at it.

It also aims to stimulate creativity between the participants and challenge them to transform EEE waste into an upcycled art object.

Encourage participants to replicate this workshop with their own audience.

Key Concepts: e-waste; creativity; innovation; recycling; upcycling; sustainability

Materials Needed:
Computer, projector, room with table and chairs, different electrical cables from a dismantled industrial machine, a second-hand wooden frame, cotton yarn, wool and fabric scraps.

Contents of the workshop:

• Upcycling: Definition of the upcycling concept, its history, principles,
• Identify the different categories of e-waste,
• Environmental impacts of e-waste,
• Building of new products by trainees based on e-waste materials.

Objectives to be achieved with the Workshop:
• Avoid wasting potentially useful materials;
• Understand the importance of reducing our ecological footprint;
• Stimulate the look at creativity;
• Understand the concept of upcycling;
• Understand the importance of the way we consume;
• Eliminate e-waste building new products;
• Understand and encourage our social and environmental responsibility;
• Learn transformation techniques depending on the materials to be used;
• Identify and handle different tools and manual techniques;
• Stimulate demand for second-hand products or upcycling products.

Methodologies:

• Expository Method - allows the transfer of learning by explanation of knowledge;

• Demonstrative Method - allows transferring performance/accomplishment skills through the description of procedures, tasks, processes. The trainer teaches by demonstrating how it is done. Contextualizes, divides into parts and practices the execution;

• Guided Discussion: This is a two-way discussion between trainer and trainees. It supports synchronous and dialectical learning environments through spontaneous and free flows of information exchange. It encourages active and participatory learning that supports knowledge transfer through dialogue. Trainees can discuss materials in more depth, share views and experiences and answer questions;

• Imaginary/Creative Method - imagining is the visualization of objects. It allows the internal visualization of images related to the information to be learned. It helps to create or recreate an experience in the trainees' minds that involves all the senses: visual, kinesthetic, audio and tactile.

Description of the activity:

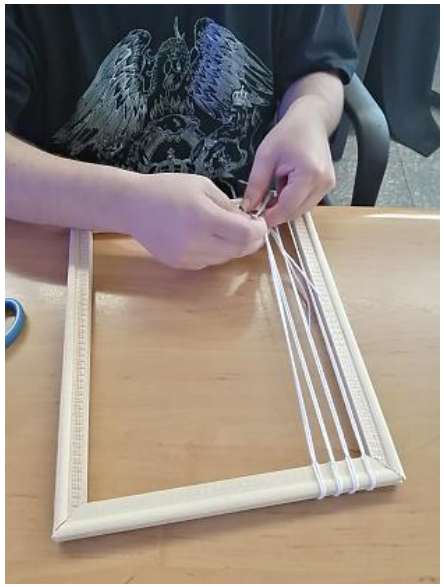
Introduction: The instructor, using the expository method and a power-point resource, introduces the concepts of upcycling and e-waste. Then shows the amount of e-waste produced in the world and how it is treated. Explains the destiny of e-waste, different categories and composition of materials in e-waste. Gives examples of products that can be re-used taken from it like, plastic, silver and gold.

Then in a guided discussion promotes reflection on the behaviour of each participant in relation to e-waste.

Development: Using demonstrative and imaginary/creative methods, the instructor presents and explains the origin and composition of the e-waste material that is going to be used.

Then explains the way to create the tapestry:

1. Using a second-hand wooden frame, explain how to lay the cotton threads to build the web for the tapestry;



2. Then explain how to cross, in the frame, the wires and textile fabrics, creating different patterns.

During the tapestry creation the instructor promotes participants' creativity and encourages them if they face difficulties.

Results: Individual tapestries for decoration or other usage.

CIAPE – Centro Italiano per l'Apprendimento Permanente
Rome, Italy

by Antonelly Menna, CIAPE – Italian Permanent Learning Centre

"Floppy goes"
Transforming old floppy discs into new products

Workshop duration: 1,5 h

Participants: 10 adults

Summary Description of the Activity:
The activity focuses on the recycling and upcycling of floppy disks, converting them into new useful and creative items

Key Concepts:
e-waste; creativity; innovation; reusing; recycling; upcycling; sustainability

Materials Needed:
Floppy disks, clamps, cable ties, scissors, glue, cutter, tape

Contents:
• Introduction about upcycling, recycling, and reusing
• Identify the e-waste pieces and element we all have at home
• Building new products starting from these materials (floppy disks).

Objectives to be achieved with the Workshop:

- To understand the importance of recycling, reusing and upcycling things and to reduce the ecological footprint;
- To avoid wasting reusable materials;
- To stimulate creativity in adult people;
- To make adult people ecologically aware;
- To acquire skills of using materials from dismantling other appliances and/or for recycling

Methodologies:

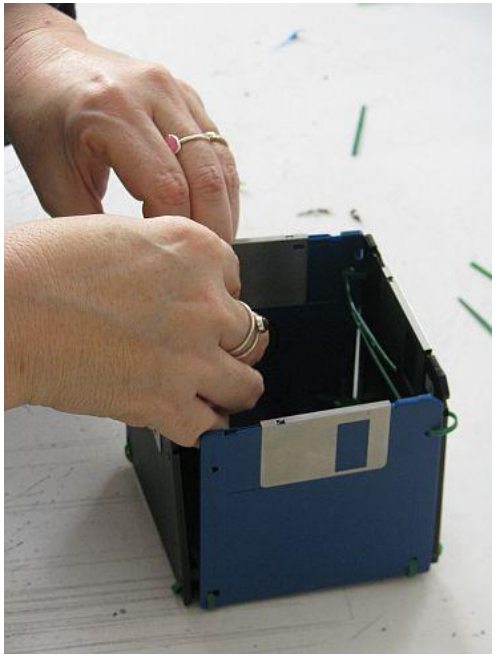
Narrative part: introduction about upcycling, recycling, and reusing.

Working part: creative process to give new life to the identified e-waste material.

Description of the activity:

With floppy disks we have at home since the 80s/90s of the last century it is possible to make several new useful things.

With no kind of effort, you can just convert them in coasters, but they can also become fantastic pen holders. Hanging 5 of them and attach them to each other with glue or cable ties that are inserted into the corner holes of the disks. The pen holder is ready to be used and possibly decorated as you prefer. Making room to the imagination and creativity, this shape can be adapted to several uses: make up cases, desk organizers, jewellery boxes, plant pots…



Results:

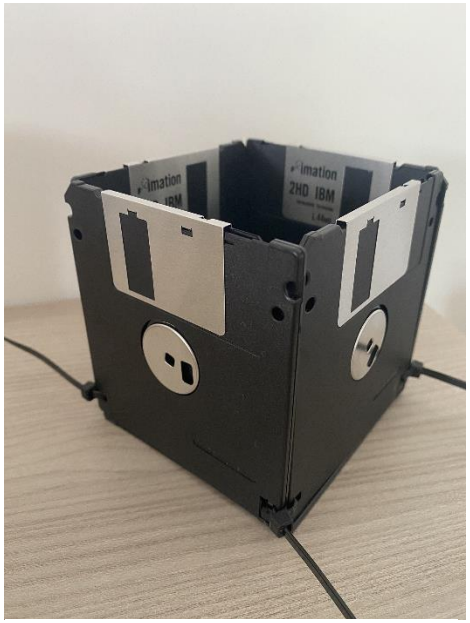
- Coasters
- Pen Holder
- Plant Pot
- Make up case
- Desk organizer
- Jewellery box

Coasters

Pen holder

Plant pot

Make-up case



Desk organizer

Jewellery box

Ośrodek Sztuki, Miejska Strefa Kultury w Łodzi
Lodz, Poland

by Anna Gajda, Community Center for Arts and Culture, Lodz, Poland

New CD time

Creating a decorative clock from an old CD

Workshop duration: 3 hours

Participants:
Group of adults up to 8 people. Can be divided by age or other criteria.

Concept:
Not sure what to do with old CDs?
The round shape brings to mind many everyday objects. One of them is a clock. The CD can be used as a clock face.
In order to increase the decorative and functional qualities of this new object made of electronic waste, it was decorated with the artistic craft technique of decoupage.

Methodology: decoupage

Results achieved:

- Made utilitarian object: clock
- Acquired skills of using materials from dismantling other appliances and/or for recycling
- Increased environmental awareness
- Training of manual skills, coordination
- Development of creative skills (imagination, creativity)

Materials:

- CD
- clock mechanism
- battery, hands and numerals
- decoupage accessories (glue, brush, paint, table napkins, scissors)
- disassembled and stripped electrical cables and the copper or aluminium wire from them

Course of the workshop:

1) Painting a CD with acrylic paint.
   We apply 2 layers of paint using a sponge, the so-called tapping technique.

2) Preparing the decorative motif.

Cut or tear a CD-sized shape out of a table napkin. Fold the napkin to obtain a thin layer of printed paper.

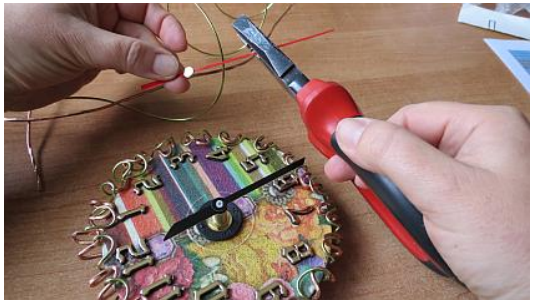
Glue the decorative pattern onto the CD. You can combine patterns from different napkins.
Next, apply a layer of decoupage varnish to the decorated plate.

3) Bend the wire obtained from the cable into a decorative frame.

Place the bent shape on the plate.

4) Stick the numbers on the face of the clock.

5) Fit the clock mechanism. Fit and install the hands.



Ready!

MIGK – Muzeji i galerije Konavala
Konavle, Croatia

by Anita Arbulić Vujasin and Petra Brailo, MIGK – Museum and Galleries of Konavle

Woven coaster

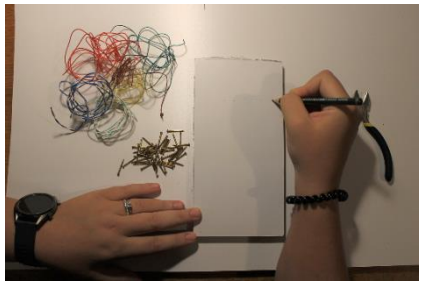
Electric wires transformed into a coaster

In traditional communities, weaving enabled the production of all clothing and most of the household textiles. Today's weavings are produced in a modern technological way, far from our experiences. Therefore, as a reminder of an almost forgotten skill, let's make a coaster in a creative, upcycling way.

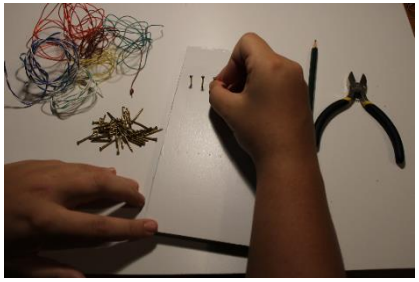
Required material:
pliers, nails, wires from e-waste, pencil, hard surface of smaller dimensions (wood, kapa fix, cardboard…)

Step 1: mark the hard surface in the places where the nails will be placed (according to your wishes)

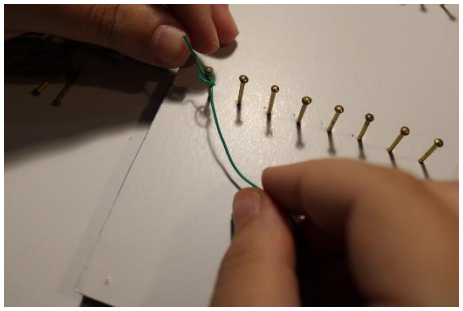
Note: denser placement of nails results in denser weaving; if a thicker wire is used, it is necessary to leave more space between the nails for easier manoeuvring



Step 2: place the nails in the marked spots

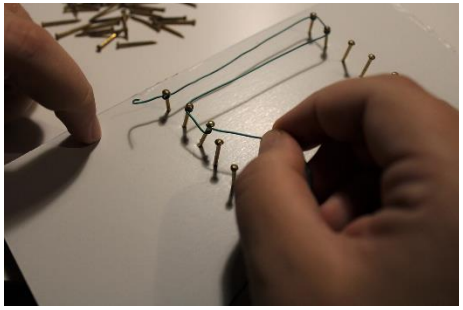


Step 3: fasten the wire using a simple knot on the first nail at the edge (setting the warp)



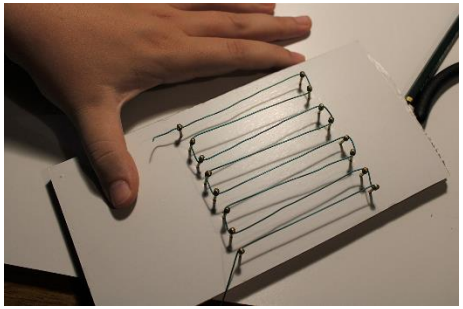
Step 4: wrap the wire once around the opposite nail

Step 5: wrap the wire once around the adjacent nail

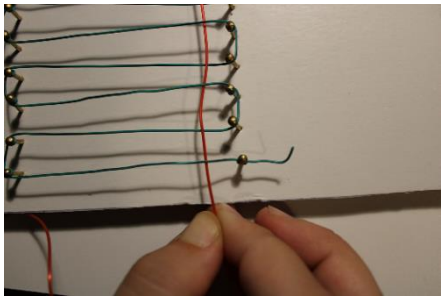


Step 6: wrap the wire once around the opposite nail, and repeat the above mentioned action with the other nails in a row

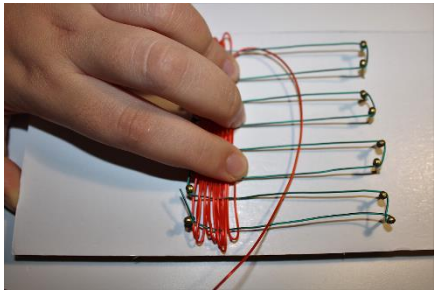
Step 7: tie a knot on the last nail

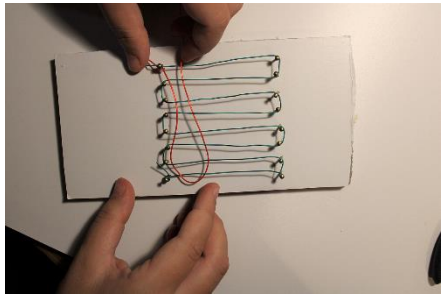


Step 8: take a new wire (laying the weft), and pass it under and over the already placed wire (warp), as close as possible to the nails



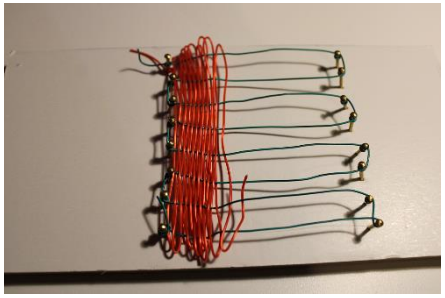
Step 9: reaching the last wire of the warp, continue with the already mentioned weaving of the weft but this time in the opposite direction



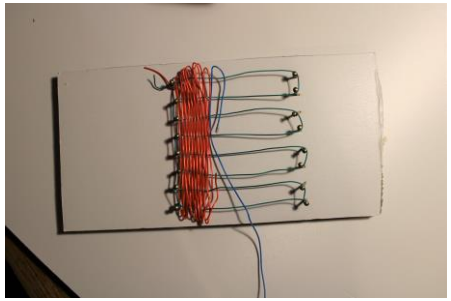


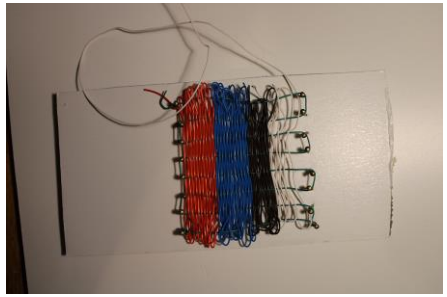
Note: during threading, i.e. weaving, it is important to compact the weft wire with fingers as close as possible to the nails

Step 10: repeat the process of weaving until the wire (weft) is used up
Note: the end of the wire (weft) only needs to be simply twisted around the warp

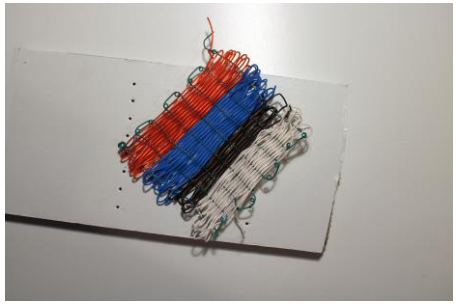


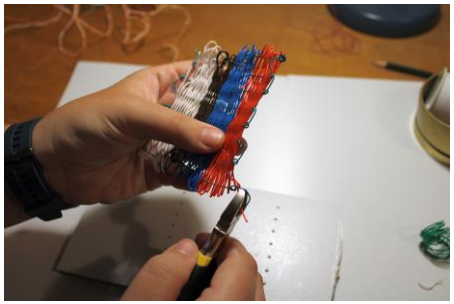
Step 11: take a new wire and repeat the same process until you reach the end of the warp, i.e. the opposite row of nails





Step 12: at the end of the weaving, remove the nails





Note: use pliers to remove the ends of the wire, i.e. excesses sticking out

Optional: to flatten the coaster a bit, briefly press with an iron or other source of heat.

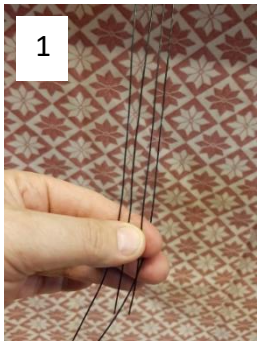
Ready for coffee!

Norrköpings stadsmuseum,
Norrköping, Sweden

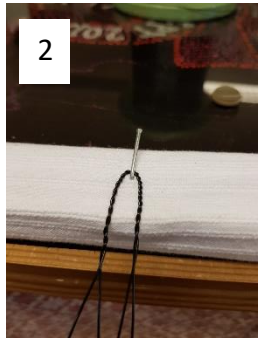
by Anette Kindahl, Norrköping City Museum
Photos: Sofia Wallin

“Tom Cruise bomb wire workshop”

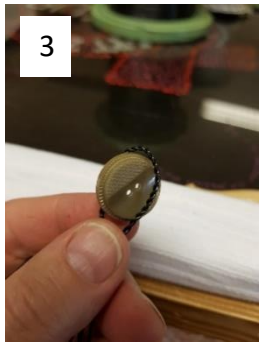
Making bracelets out of electric wires using macramé technique



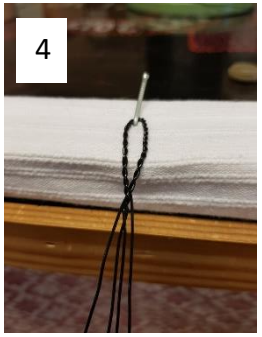
You need a double wire that measures the circumference of your wrist plus 5 cm. And a double wire that is about 80 cm. Place a nail in a wooden slat and fasten the slat to a table with clamps. I even have a fabric around the bar to avoid splinters.



Twist the short and the long wire together in the middle of the long one.

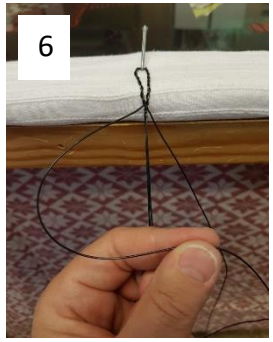


Take a nice button for locking and test so that it can be put through the loop that you have just formed. Set the button aside.

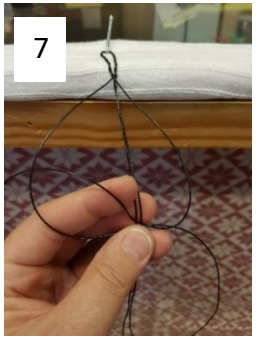


Place the loop around the nail. Twist the two short wires in the middle a couple of turns, the long ones can stay as they are.

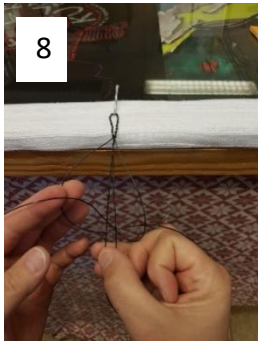
Tie a string around your waist and attach the end of the short wires to the string to simplify the macramé braiding.



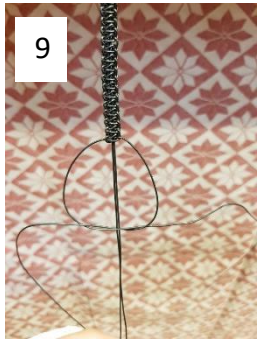
Take the left long wire and place it over the two short ones.



Now place the right long over the left long. Go under the two short ones with the right long one and up in the loop on the left side.

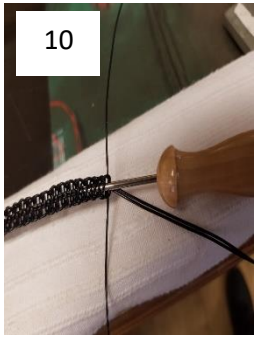


Pull up the right long one in the left loop and slowly pull on the two long cables so that a knot is formed around the two short cables. Then you do the same thing again but starting from the right hand side. So every other left and right.



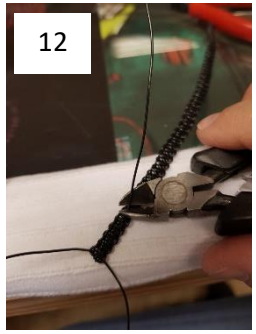
Continue with the macramé braid and test the bracelet on your hand from time to time. Remember that it is better with a slightly longer bracelet so that it does not feel uncomfortable.

Workshop: 21 April 2022 at Norrköpings stadsmuseum, with one teacher and eight participants. The objective was to learn how to use electric waste in a new way, in this case: thin electric wires left from installing a new alarm system at the museum. Calculate 2 hours' workshop time and 2 hours of preparation. The number of participants depends on how much space there is for fastening the macramé onto something, e.g. a table.



When the bracelet is the right length, remove it. Use an awl or a nail to loosen the center braid a little. Fasten the short center wires by putting the last wire in the work over them and then stuffing them back into the cavity you just made.

Stick up the wires about 2 - 3 centimeters, and make sure it looks as nice as possible.



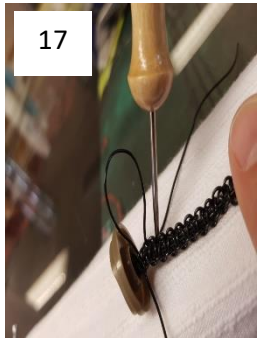
Cut the wires and, if necessary, hide them under the braid.

Cut the long wires to about 15 centimeters if they are too long. Fasten the button.

Thread the wires through the button again so that the wires end up on the underside of the button.

Twist the wires under the button about two turns.

To attach the wires, sew back on the outer edge of the bracelet about 2-3 centimeters.



If the macramé is too tightly braided, you can also use an awl or small nail here and make it easier to sew with the cable and finish by pinching off the wires.

Finished bracelet!

Beeswax Wraps

The alternative for tin foil, plastic wrap or Tupperware type containers

Are you tired of industrially made, energy intensive, non recycleable wrapping for your food, and therefore looking for an alternative? Then self-made beeswax wraps are the right project for you! They are perfect to wrap and cover, in different sizes

- sandwiches to go
- veggies, bread, etc.
- glasses or cups

What you need:

- 100% cotton fabric or also linen (e.g. from old curtains, tea towels or tablecloths, napkins, bedding…)
- Natural beeswax
- Pure jojoba oil

The wraps will get in contact with your food, so it's advised to use all organic products as well as washed non-impregnated fabrics!

- Baking paper sheets
- Iron
- Pinking shears

by Felice Frank, ARGE grenzen erzählen, Vienna, Austria
Photos: Marcin Filipowicz

Medium demand production

- thin cotton cloth 60 cm x 150 cm, 30 cm x 150 cm, 20 cm x 150 cm
- 200 g beeswax
- 20ml Jojoba oil

makes for example

- 2 wax wraps size 60 x 60 cm
- 1 wax wrap size 60 x 40 cm
- 5 wax wraps size 30 x 30 cm
- 7 wax wraps size 20 x 20 cm

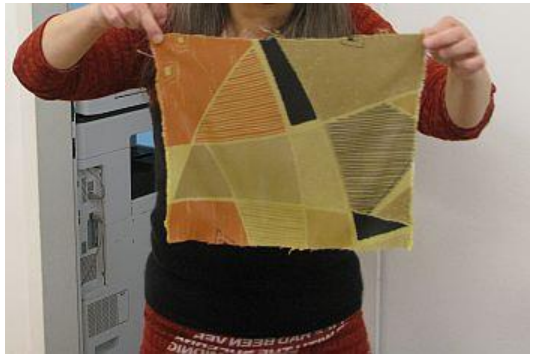
STEP 1 Mix Beeswax and Jojoba oil (10%)

STEP 2 Place fabric on baking paper

STEP 3 Distribute wax-oil mixture equally on fabric

STEP 4 Cover with a second sheet of baking paper, iron (middle temperature, no steam). Distribute evenly, if necessary patch where needed.

STEP 5 Let cool



STEP 6 Cut to size and trim edges

When used, wipe clean with warm water and let dry. If necessary, refresh by ironing out wrinkles.

Notes

[i] EUR-Lex – Access to European Law: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0474; accessed 20.08.2022
[ii] United Nations, UNRIC, https://unric.org/de/17ziele/; accessed 20.08.2022
[iii] European Commission's Raw Material Initiative https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52008DC0699&from=EN , accessed 21.08.2022
[iv] European Commission: https://rmis.jrc.ec.europa.eu/?page=crm-list-2020-e294f6 , accessed 21.08.2022
[v] European Commission: https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1542 , accessed 21.08.2022
[vi] European Parliament: https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits; https://www.crmalliance.eu/critical-raw-materials , accessed 20.08.2022
[vii] European Commission: https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en; accessed 21.08.2022
[viii] European Parliament: Ibid.