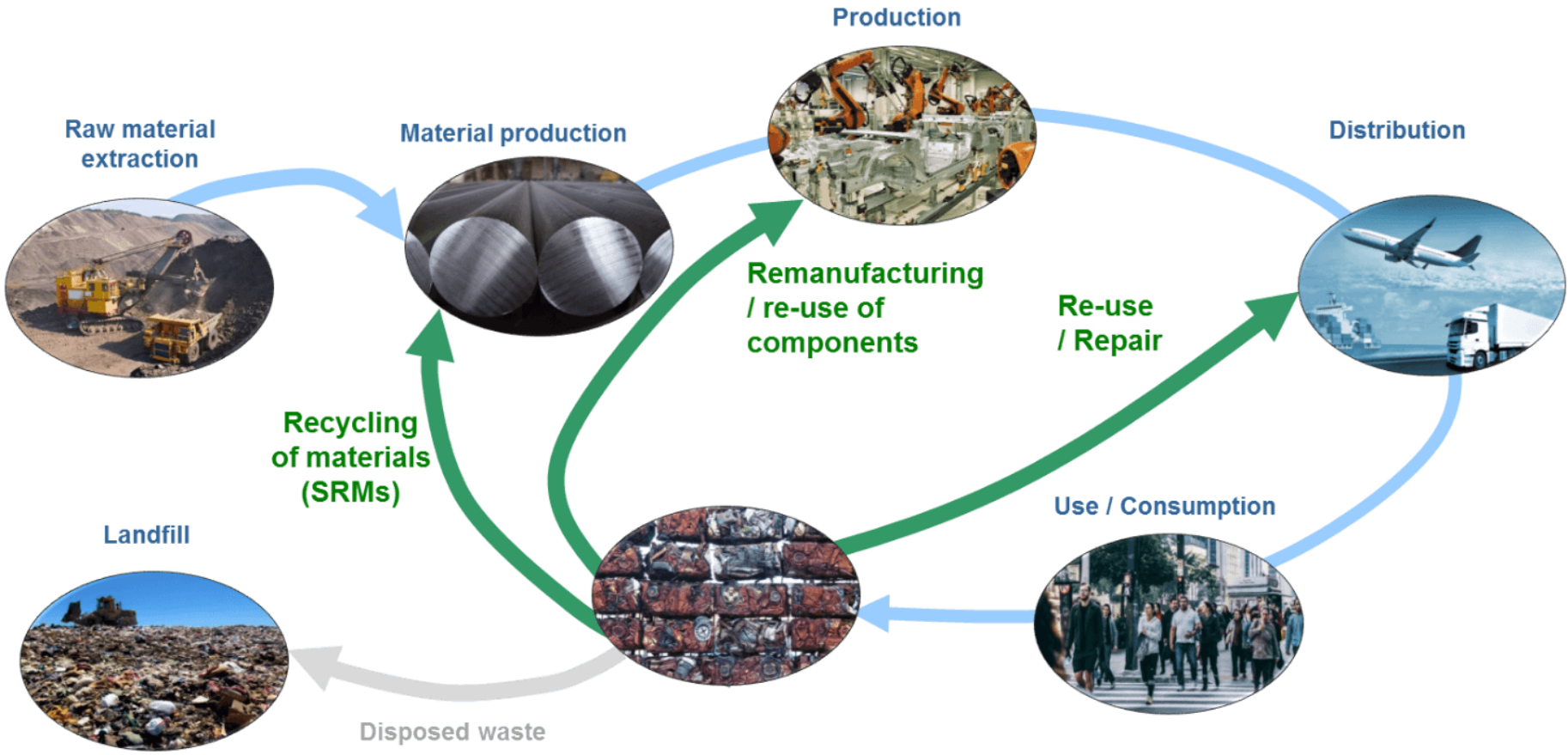
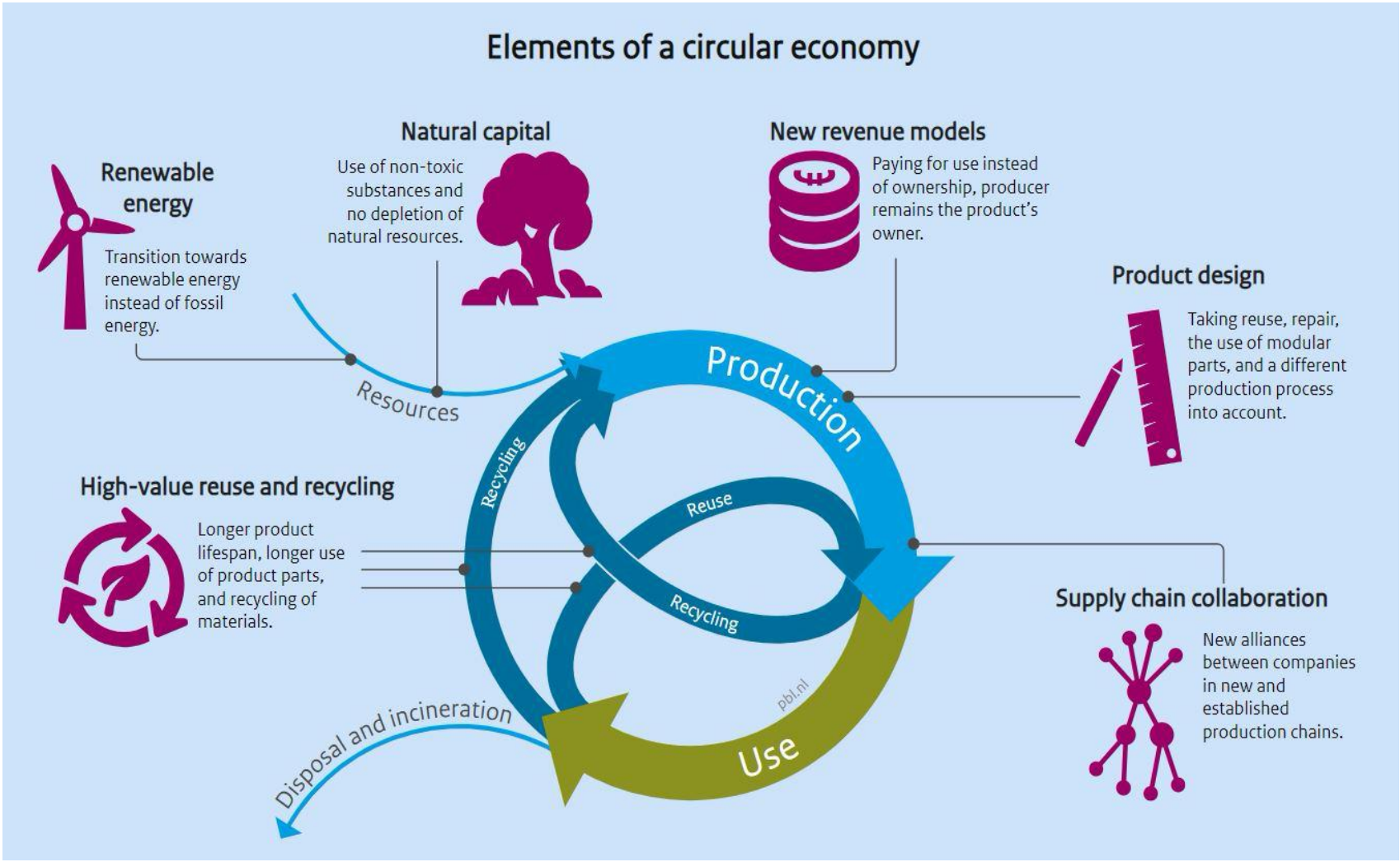
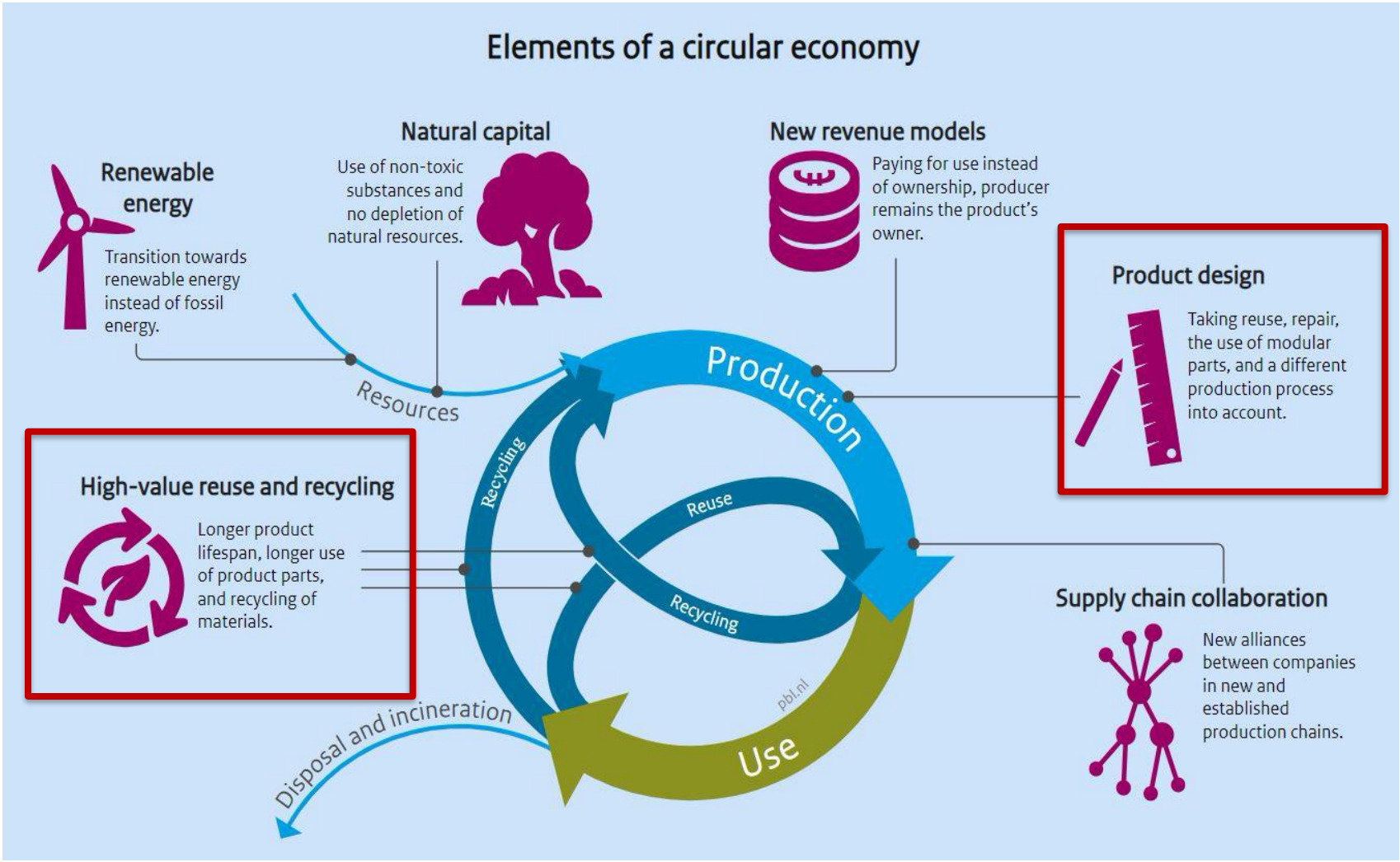
Resources life cycle



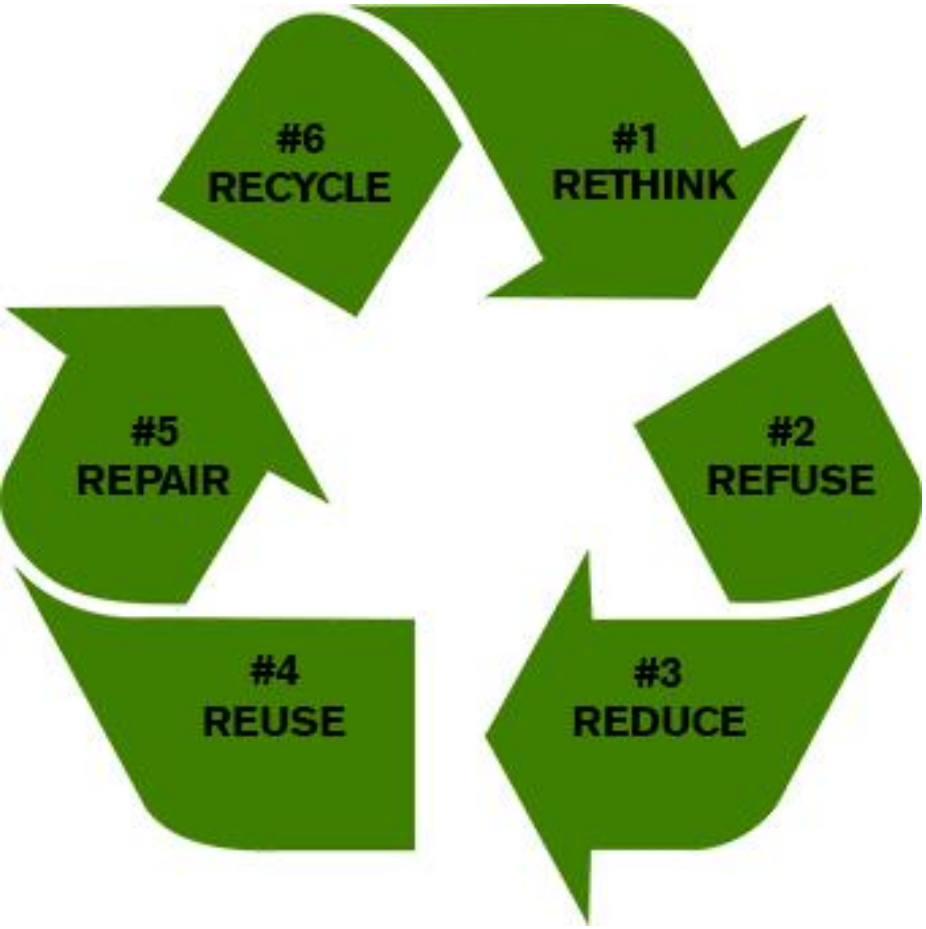
Circular Economy: the elements and the value chain



Circular Economy: the elements and the value chain



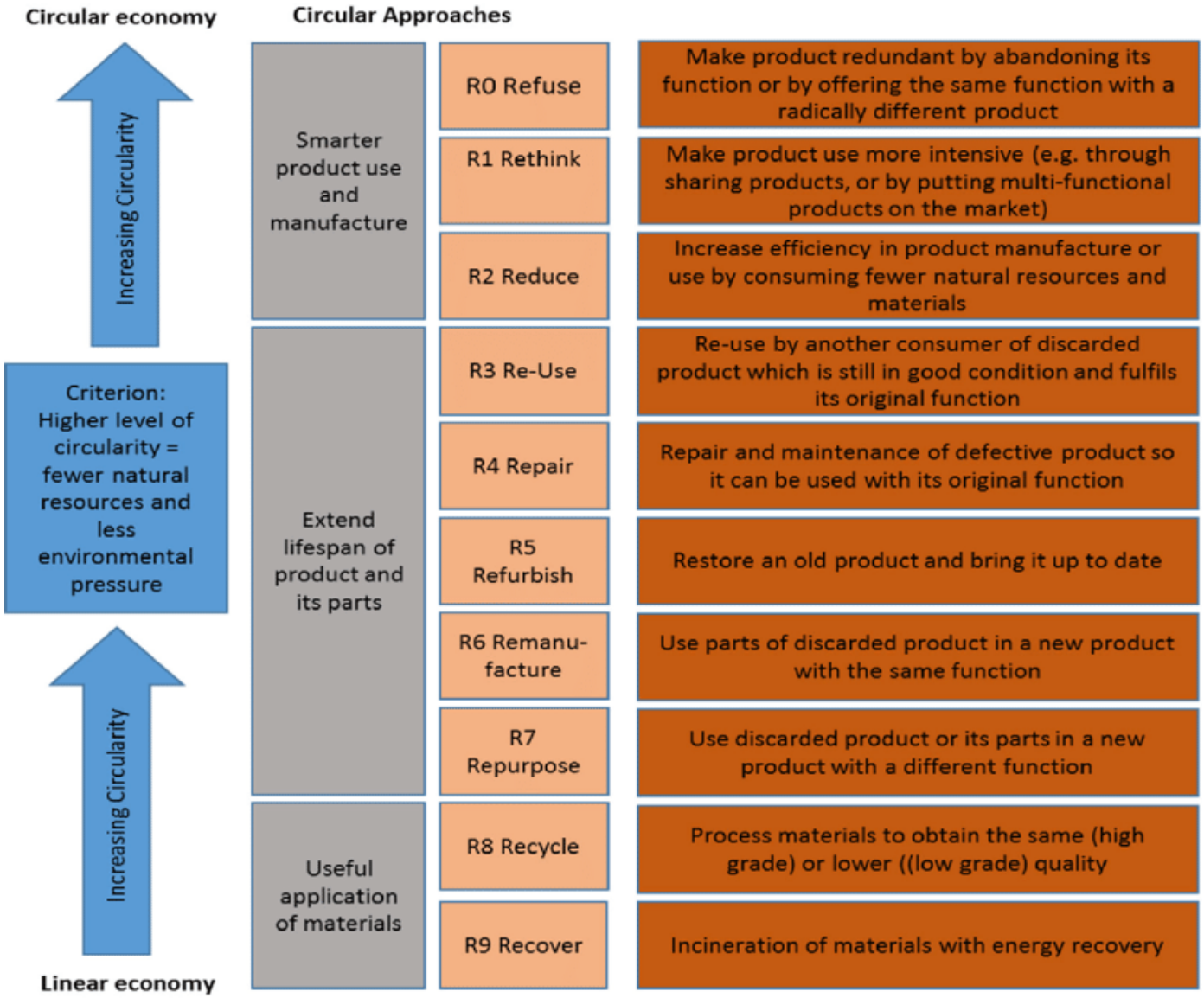
The 6 «R» of Circular Economy



1. **Rethink: Is there a better way to solve this problem that is less harmful to the environment?**
2. Refuse: Not accepting things that are not the best option for the environment.
3. **Reduce: Is it possible to reduce the amount of material used to help protect valuable resources?**
4. Reuse: Can the product have another use? Can its parts be used in other products?
5. Repair: Is the product easy to repair?
6. **Recycle: Can materials in the product be recycled and used again?**

https://www.chalmers.se/en/areas-of-advance/production/research/sustainable-production/Pages/default.aspx

The 9 (or 10) R of circular economy



Source of the picture: Okorie, Okechukwu & Salonitis, Konstantinos & Charnley, Fiona & Turner, Chris & Moreno, Mariale & Tiwari, Ashutosh. (2018). Digitisation and the Circular Economy: A Review of Current Research and Future Trends. Energies. 11. 3009. 10.3390/en11113009.

The 9 R of circular economy

- R1 Refuse Make product redundant by abandoning its function or by offering the same function by a radically different (e.g. digital) product or service
- R2 Rethink Make product use more intensive (e.g. through product-as-a service, reuse and sharing models or by putting multi-functional products on the market)
- R3 Reduce Increase efficiency in product manufacture or use by consuming fewer natural resources and materials
- R4 Re-use Re-use of a product which is still in good condition and fulfils its original function (and is not waste) for the same purpose for which it was conceived
- R5 Repair Repair and maintenance of defective product so it can be used with its original function
- R6 Refurbish Restore an old product and bring it up to date (to specified quality level)
- R7 Remanufacture Use parts of a discarded product in a new product with the same function (and as-new-condition)
- R8 Repurpose Use a redundant product or its parts in a new product with different function
- R9 Recycle Recover materials from waste to be reprocessed into new products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations

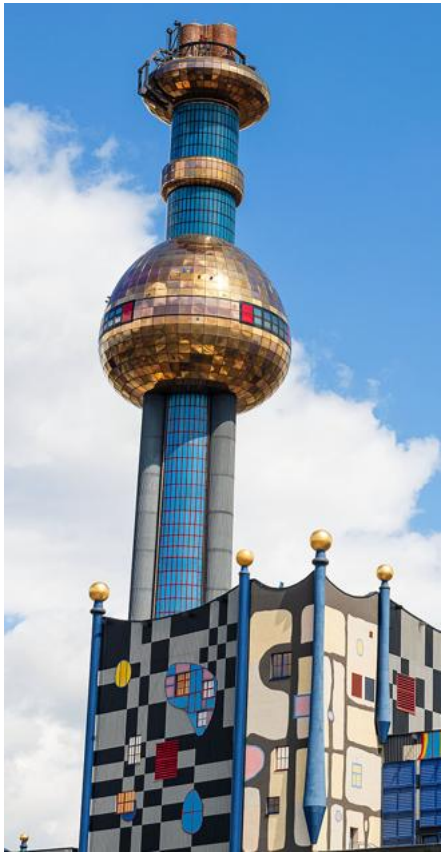
Source: Categorisation system for the circular economy (European Commission, 2020)

The 10th R of circular economy?

- A further R-strategy often mentioned in combination with the above 9Rs, sometimes even as part of a circular economy definition, is the **recovery of (embodied) energy from wastes and residues.**

- The CE Finance Expert Group acknowledges that from a waste management angle, energy recovery is an environmentally preferable option to landfill disposal in accordance with the waste hierarchy principle. Additionally, the recovery of energy from organic wastes and residues of renewable origin, including the production of fuels therefrom, may contribute substantially to climate change mitigation by displacing consumption of fossil fuels.

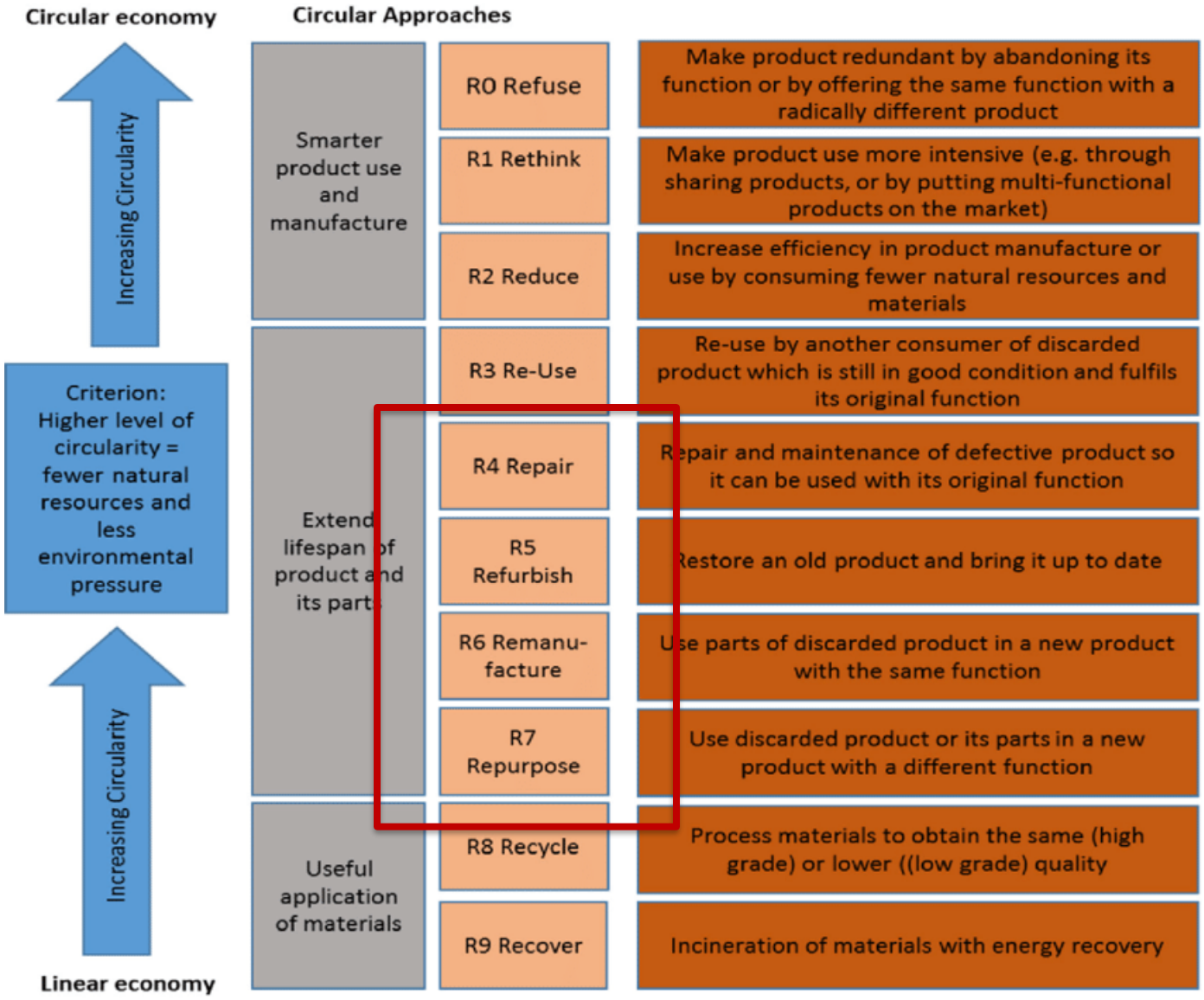
- However, a majority of CE Finance Expert Group members considers that the resource efficiency gains from waste-to-energy and waste-to-fuel strategies are fairly modest in comparison with the other 9Rs, particularly when considering the loss in economic value of potentially recyclable materials through incineration



Picture: Spittelau waste incineration plant, Vienna

Source: Categorisation system for the circular economy (European Commission, 2020)

The 9 (or 10) R of circular economy



Source of the picture: Okorie, Okechukwu & Salonitis, Konstantinos & Charnley, Fiona & Turner, Chris & Moreno, Mariale & Tiwari, Ashutosh. (2018). Digitisation and the Circular Economy: A Review of Current Research and Future Trends. Energies. 11. 3009. 10.3390/en11113009. *NOTE R4 and R6 can be in some source inverted*

The 9 R of circular economy explained

R4 Repair:

- *'Repairing is simply the correction of specified faults in a product. When repaired products have warranties, they are less than those of newly manufactured equivalents. Also, the warranty may not cover the whole product but only the component that has been replaced'*

R5 Reconditioning/refurbishment:

- *'Reconditioning is the process of returning a used product to a satisfactory working condition that may be inferior to the original specification. Generally, the resultant product has a warranty that is less than that of a newly-manufactured equivalent. The warranty applies to all major wearing parts'*

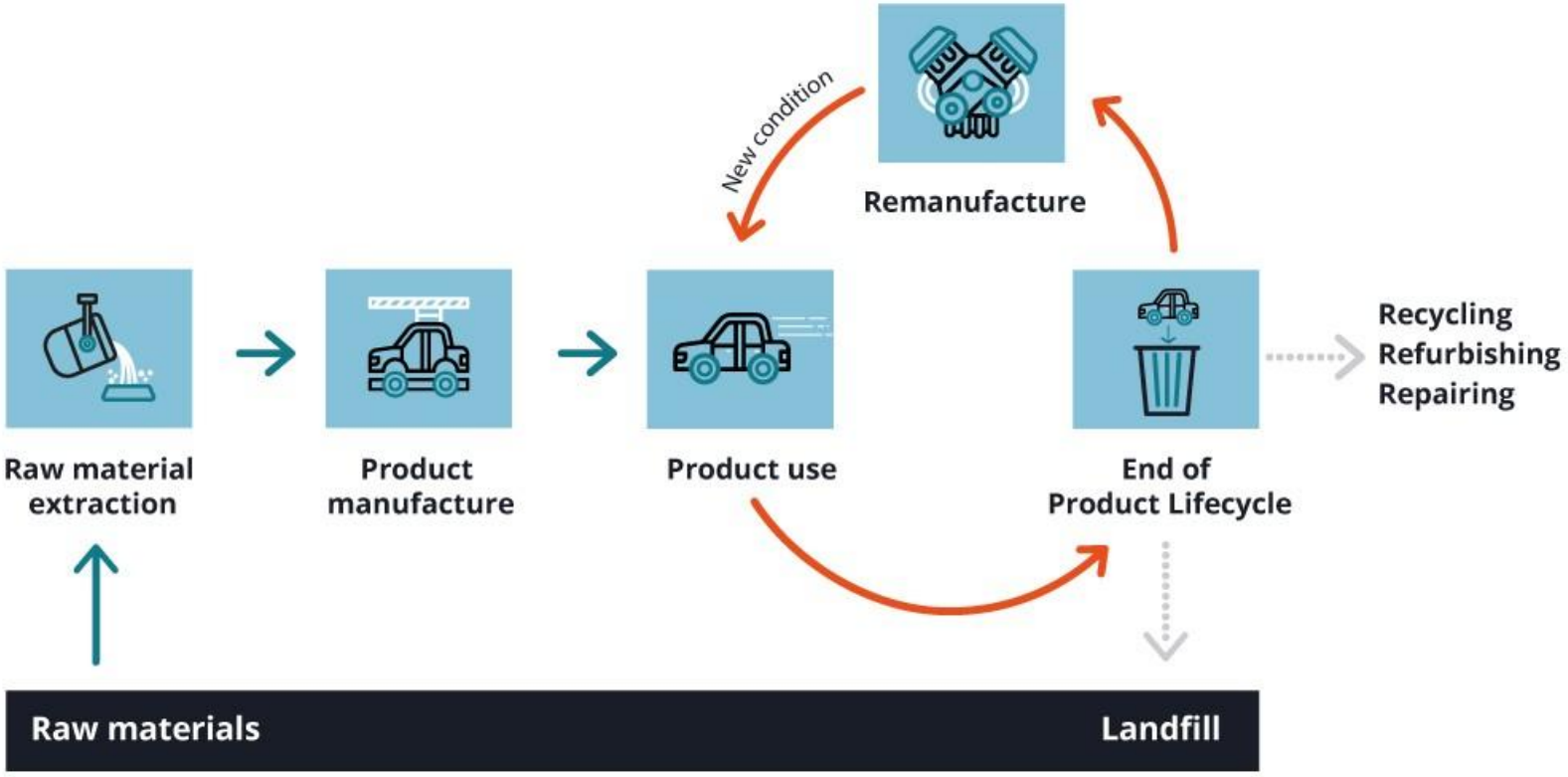
R6 Remanufacturing:

- *"returning a used product to at least its original performance with a warranty that is equivalent to or better than that of the newly manufactured product"*

Remanufacturing

Remanufacturing is defined as the **'process of returning a used product back to at least as-new condition with at least as – new warranty.'** **Remanufacturing** a product begins a new lifecycle for that product. And when products are initially designed to be remanufactured, this process can continue indefinitely.

[Dr Winifred Ijomah, Technical Director: Scottish Institute for Remanufacturing]



Source: https://www.scot-reman.ac.uk/remanufacturing-explained/

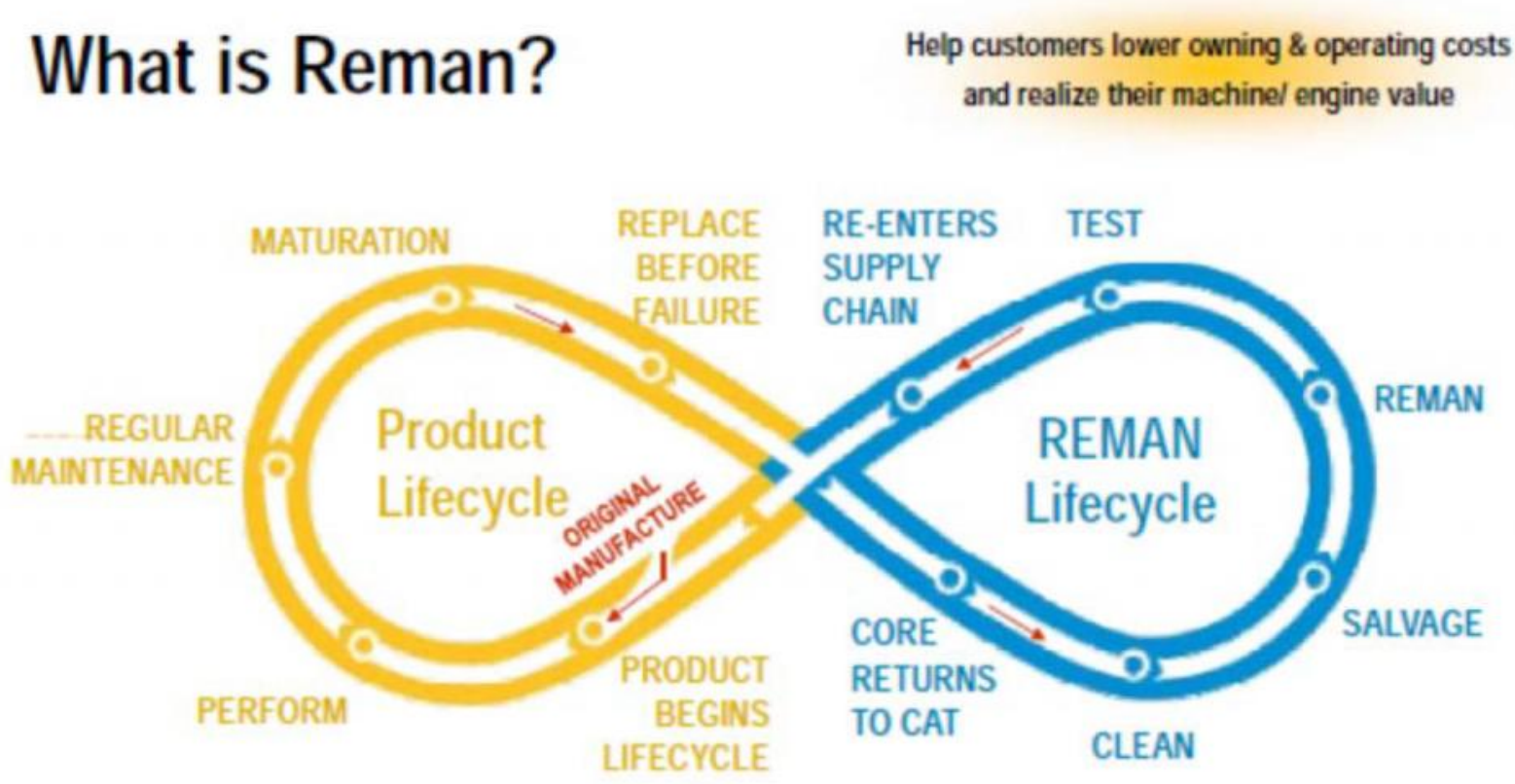
Remanufacturing

Terminology used to describe remanufacturing can vary between sectors – titles such as servicing, overhauling, reconditioning and refurbishing are more familiar ways of talking about remanufacturing within some industries.
When the process referred to fits the definition of remanufacturing, returning a used product back to at least as-new condition, then this is classed as remanufacturing.

However, remanufacturing is different, to other Circular Economy terms, namely re-use, repair and recycling and **this difference needs to be noted.**

Recreating unique technology with professional remanufacturing (video)
https://www.youtube.com/watch?v=84ET6-W2wDM

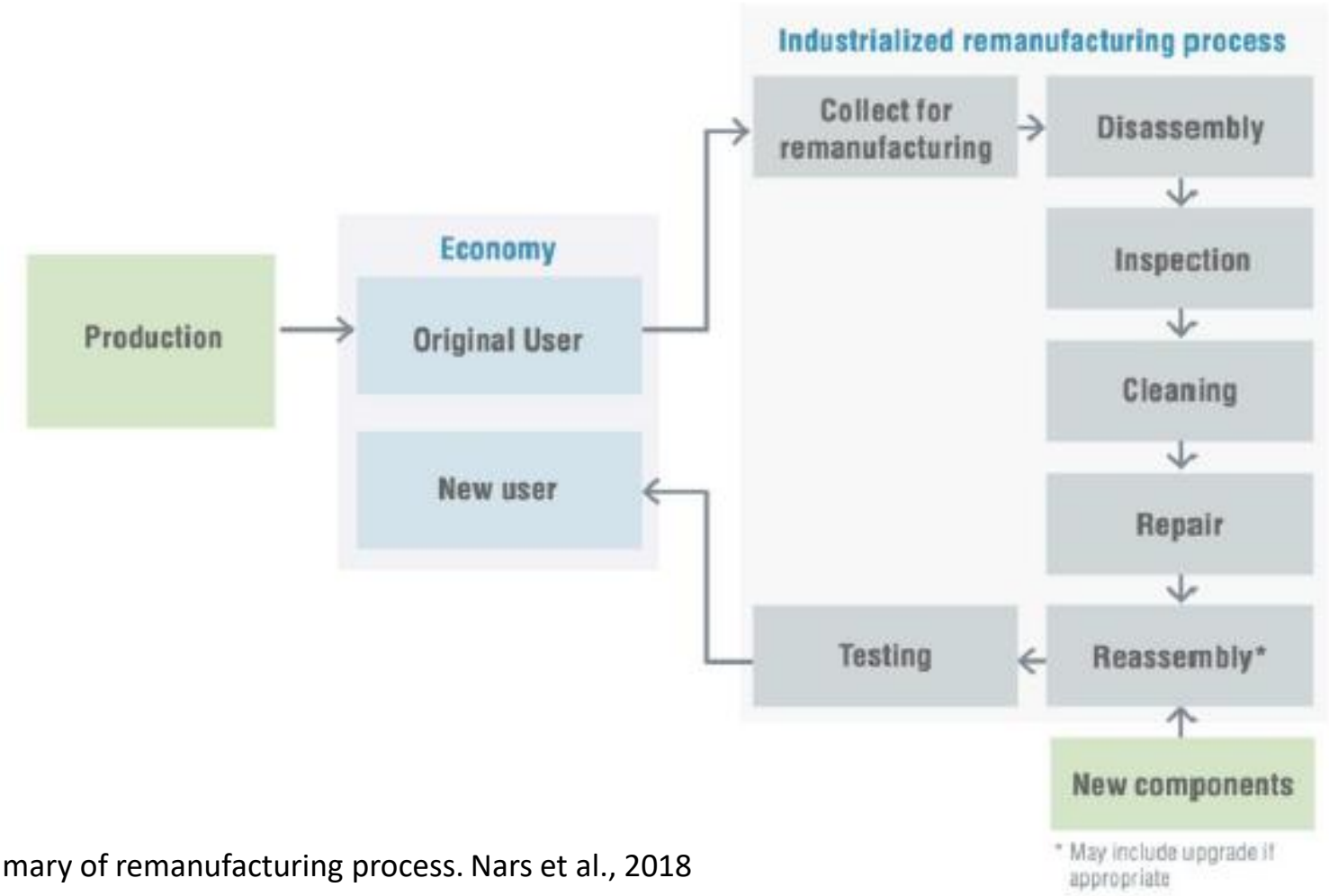
Remanufacturing



Remanufacturing: The industrial process of returning an end-of-service-life, broken or blemished product to "same-as-when-new" condition in a manufacturing environment.

Source: http://www.circulary.eu/project/caterpillar-remanufacturing/

Remanufacturing



Summary of remanufacturing process. Nars et al., 2018

Remanufacturing Council EU

Interactive seminar on 2022, Nov, 3rd
"Remanufacturing Successes – Where Next?"
(see Moodle of Master)



Conseil Européen de Remanufacture

"Our aim is to triple the sales of Europe's remanufacturing sector from €30 billion to €100 billion by 2030"

Businesses and trade association members including Michelin, Lexmark, Volvo Cars, DSV, syncreon. Based in Brussels, working with World Economic Forum, UNEP and EU Circular Economy Stakeholder Platform as well as academic research community via Professor Erik Sundin at Linkoping University.

David Fitzsimons@remancouncil.eu
www.remancouncil.eu

Remanufacturing Council EU



David Fitzsimons@remancouncil.eu
www.remancouncil.eu

Remanufacturing: an example

The engine reaches the end of its lifecycle, either through the vehicle it was within no longer being of fit use, or the engine itself failing. There are a few choices as to what happens next:

Recycling: the engine is melted down and the resulting metals would be used elsewhere, across any number of products.

Repairing: if the engine had a fault a repair would fix the specific fault – without any guarantee as to how long that fix will work, or if there are any other wear and tear red flags in other parts.

Re–using: a functioning engine would see it taken as is, and put into another vehicle.

Remanufacturing: returning the engine as a whole, to as **new**, if not better, condition.

Remanufacturing in Veneto

WayPoint

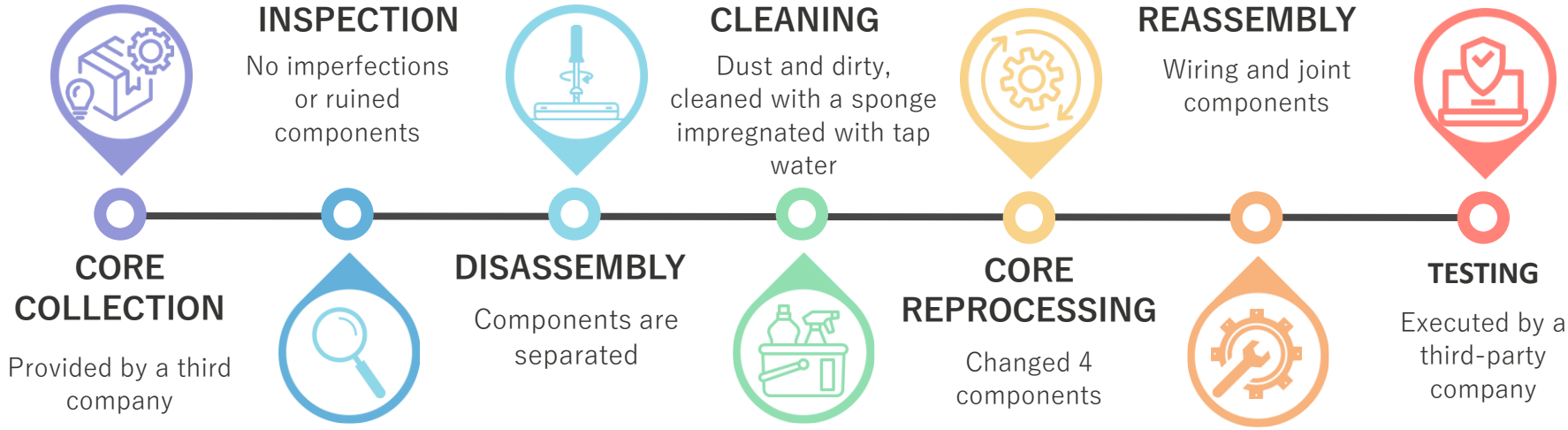
Prodotti Designers Azienda News & Press Contatti ITA

WAY POINT LIGHTING REMANUFACTURING PILOT LINE

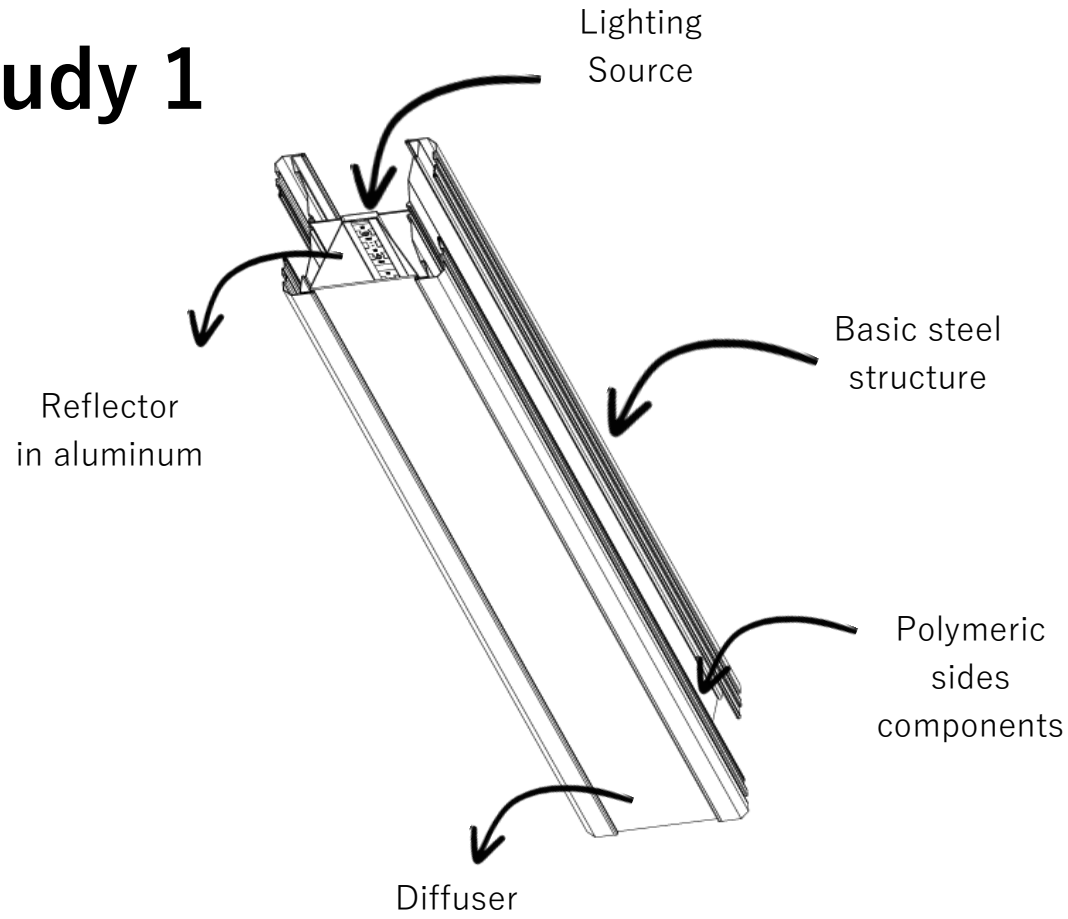


Remanufacturing in lighting

Case Study 1



Case Study 1


Lighting Source
Basic steel structure
Reflector in aluminum
Polymeric sides components
Diffuser

Technical point of the procedure - case 1

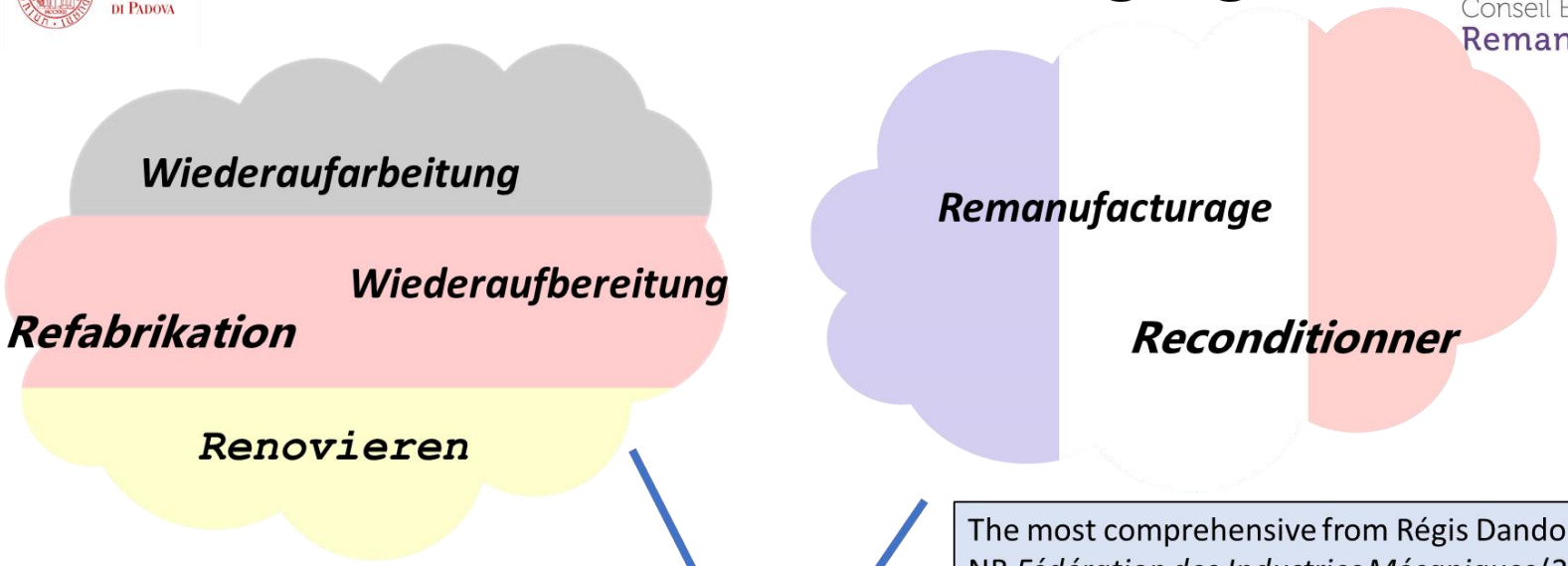
	PRODUCT COMPONENTS	FORMER COMPONENT MASS (kg)	PRESENT COMPONENT MASS (kg)	DIFFERENCE	CHANGE IN %
MANTAINED	BASIC STEEL STRUCTURE	10.00	10.00	0.00	0.00%
	POLYMERIC SIDES COMPONENTS	0.80	0.80	0.00	0,00%
REPLACED	REFLECTOR IN ALUMINIUM	0.74	1.00	0.26	35.14%
	DIFFUSER	0.00	0.66	0.66	100.00%
	LIGHTING SOURCE	0.80	0.15	-0.65	-81.25%
	CONTROL GEARS	2.61	0.72	-1.89	-72.41%

TOTAL MASS (kg) OF ORIGINAL PRODUCT	14.95
TOTAL MASS (kg) SAVED	10.80
TOTAL MASS (kg) OF NEW COMP	2.61

72 %

Remanufacturing Council EU

Other terms in other languages



Susanne Kroll, *Fraunhofer Institut*
Wolfgang Gerke, *Trier Univ. of Applied Sciences*

The most comprehensive from Régis Dando but
NB *Fédération des Industries Mécaniques* (2022)

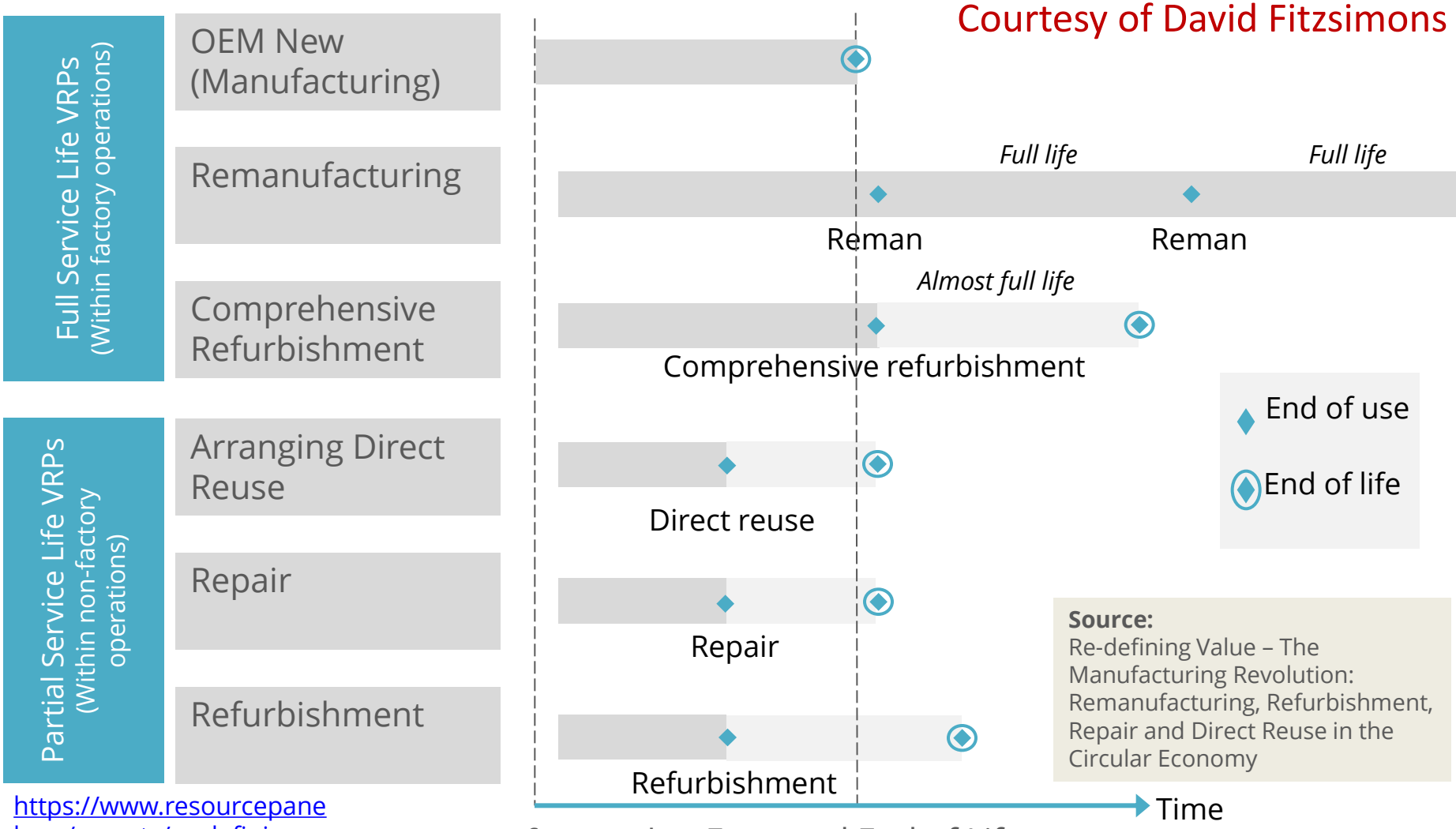
Value Retention / Product Life Extension

Courtesy of David Fitzsimons@remancouncil.eu
www.remancouncil.eu

Categories of value retention processes

original equipment manufacturer (OEM)

Courtesy of David Fitzsimons



Source:
Re-defining Value – The Manufacturing Revolution: Remanufacturing, Refurbishment, Repair and Direct Reuse in the Circular Economy

https://www.resourcepanel.org/reports/re-defining-value-manufacturing-revolution

Barriers of Remanufacturing



Reverse Logistics



Consumer Awareness



Technical Complexities



Regulatory Issues

Categorisation systems: the starting point



Categorisation systems: the starting point

In order to increase levels of financing to the circular economy, it is essential to develop a **common understanding of what the circular economy is**. This means first of all developing and agreeing on eligibility criteria (what makes a project/project component/business circular) for existing and new **financial** instruments, but also for **monitoring** purposes and for **assessing** the additionality of circular projects versus linear projects. This refers to the ability to measure the impact of a circular project, which may increase the project's prospects of being bankable.

"(…) The lack of a commonly accepted and sufficiently inclusive definition and circularity measurement methodology hampers the transition to a more circular economy in multiple ways. Among other things, it hampers the development and access to (dedicated or non-dedicated) finance, credit risk assessment, and the transferability and replicability of projects and investments across regions and jurisdictions".

Accelerating the transition to the Circular Economy - European Commission Directorate-General for Research and Innovation Directorate I — Climate Action and Resource Efficiency

Categorisation systems: the starting point



GOALS:

- contribute to the future work of the Sustainable Finance Platform on developing the EU sustainable finance **taxonomy**, identifying activities substantially contributing to the circular economy objective in the EU Taxonomy Regulation and developing related technical screening criteria

- provide guidance for developing and investing in circular economy businesses and projects. In the interim period until the Taxonomy for the circular economy objective is adopted by the EC, this work will help public authorities, businesses as well as financial institutions and investors better understand what activities/projects contribute to the circular economy.

Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: the starting point

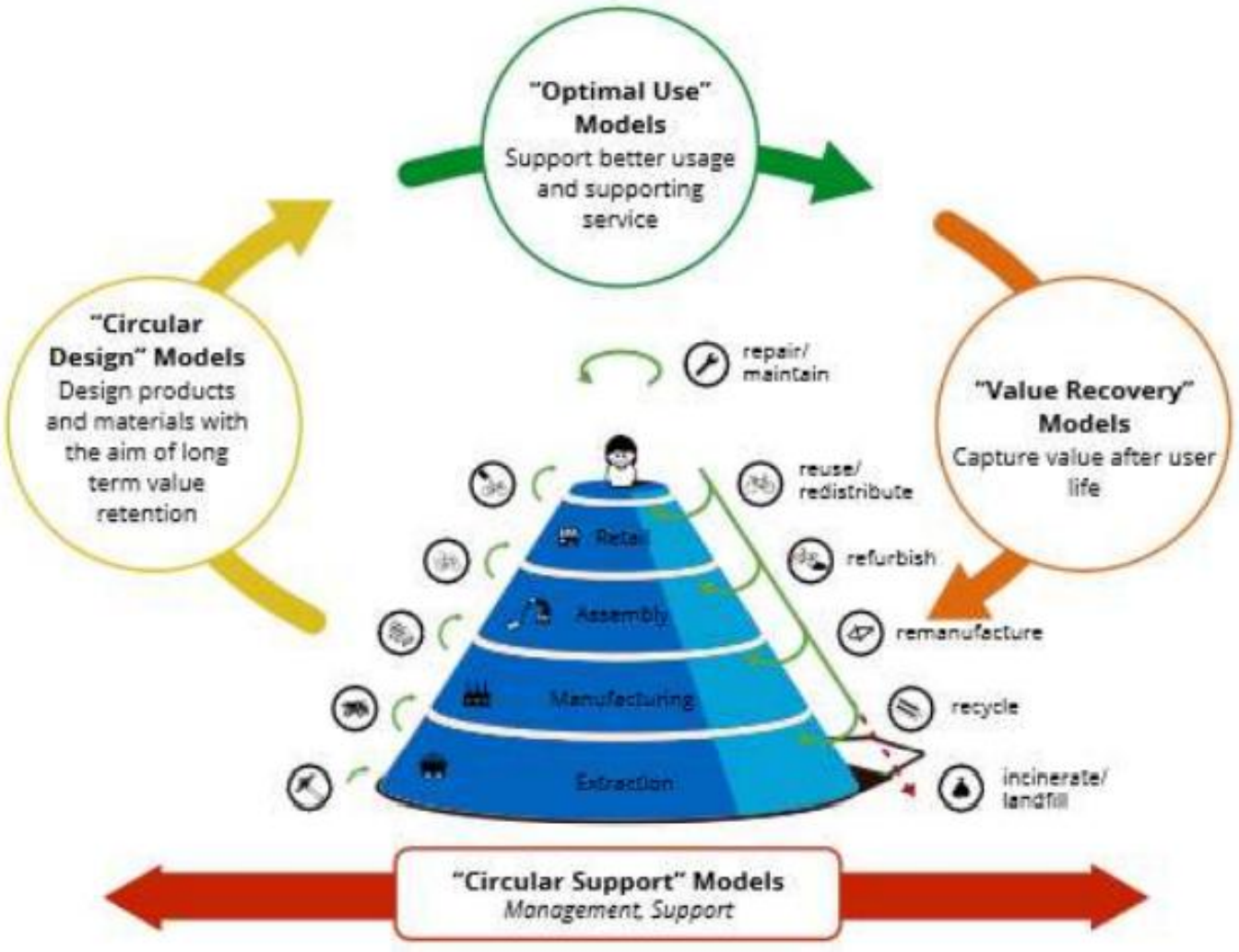


OUTPUTS:

- a generic, sector-agnostic circular economy **categorisation system** that defines distinct categories of activities substantially contributing to a circular economy;
- a **set of minimum criteria** to be met by activities under each defined category in order to be considered as substantially contributing to a circular economy; and
- methodological guidance including an indicative list of typical investments/projects for each circular economy category.

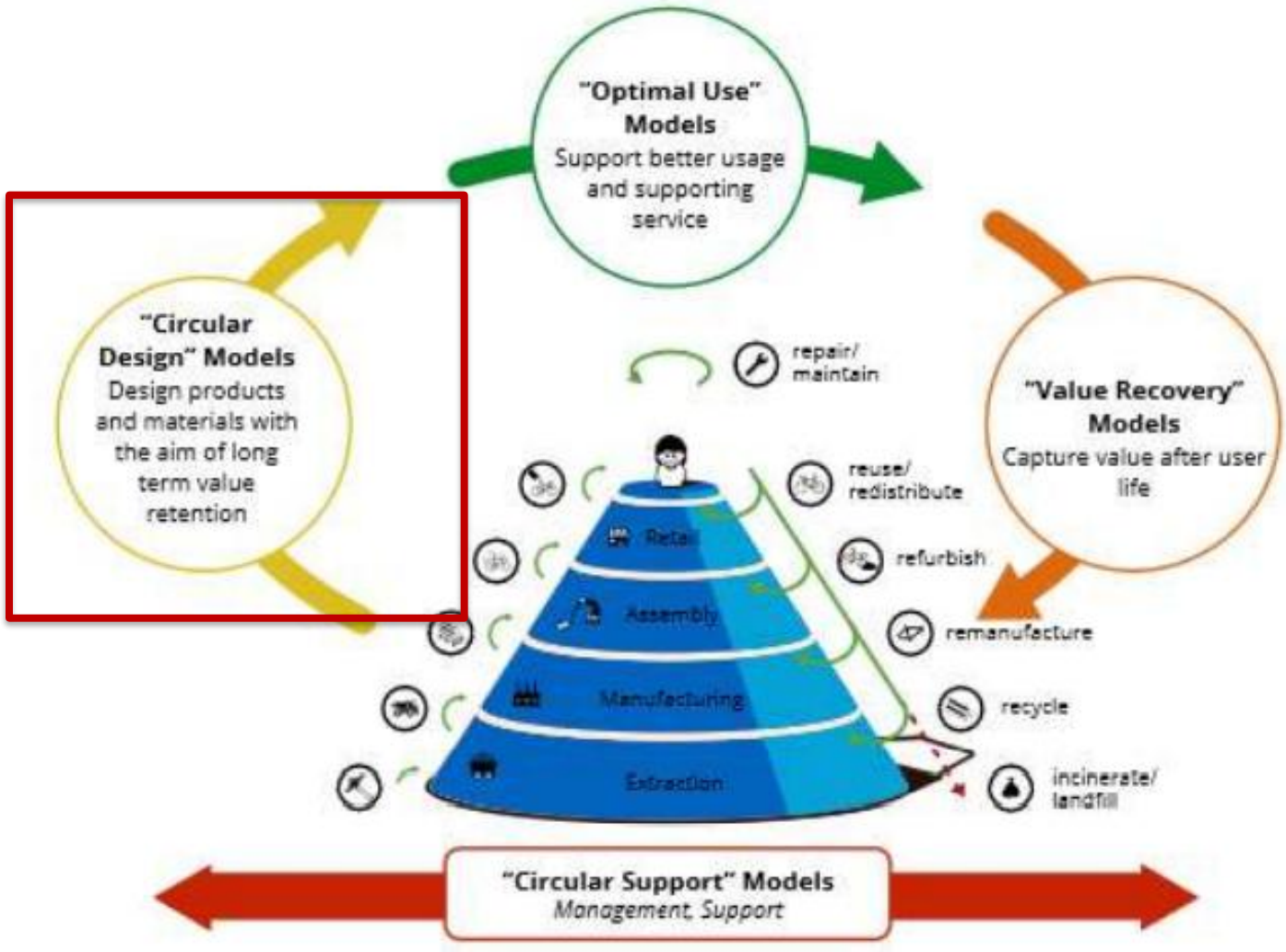
Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: the starting point



Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: the starting point



Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: circular design and production

Group 1 - Circular Design and Production Models:

1.a Design and production of products and assets that enable circular economy strategies, through e.g. (i) increased resource efficiency, durability, functionality, modularity, upgradability, easy disassembly and repair; (ii) use of materials that are recyclable or compostable

1.b Development and deployment of process technologies that enable circular economy strategies

1.c Development and sustainable production of new materials (including bio-based materials) that are reusable, recyclable or compostable [From: Elisa Achterberg, Jeroen Hinfelaar, Nancy Bocken, "The Value Hill Business Model Tool: identifying gaps and opportunities in a circular network" (2016) 6]

1.d Substitution or substantial reduction of substances of concern in materials, products and assets to enable circular economy strategies

1.e Substitution of virgin materials with secondary raw materials and by-product

Source: Categorisation system for the circular economy (European Commission, 2020)

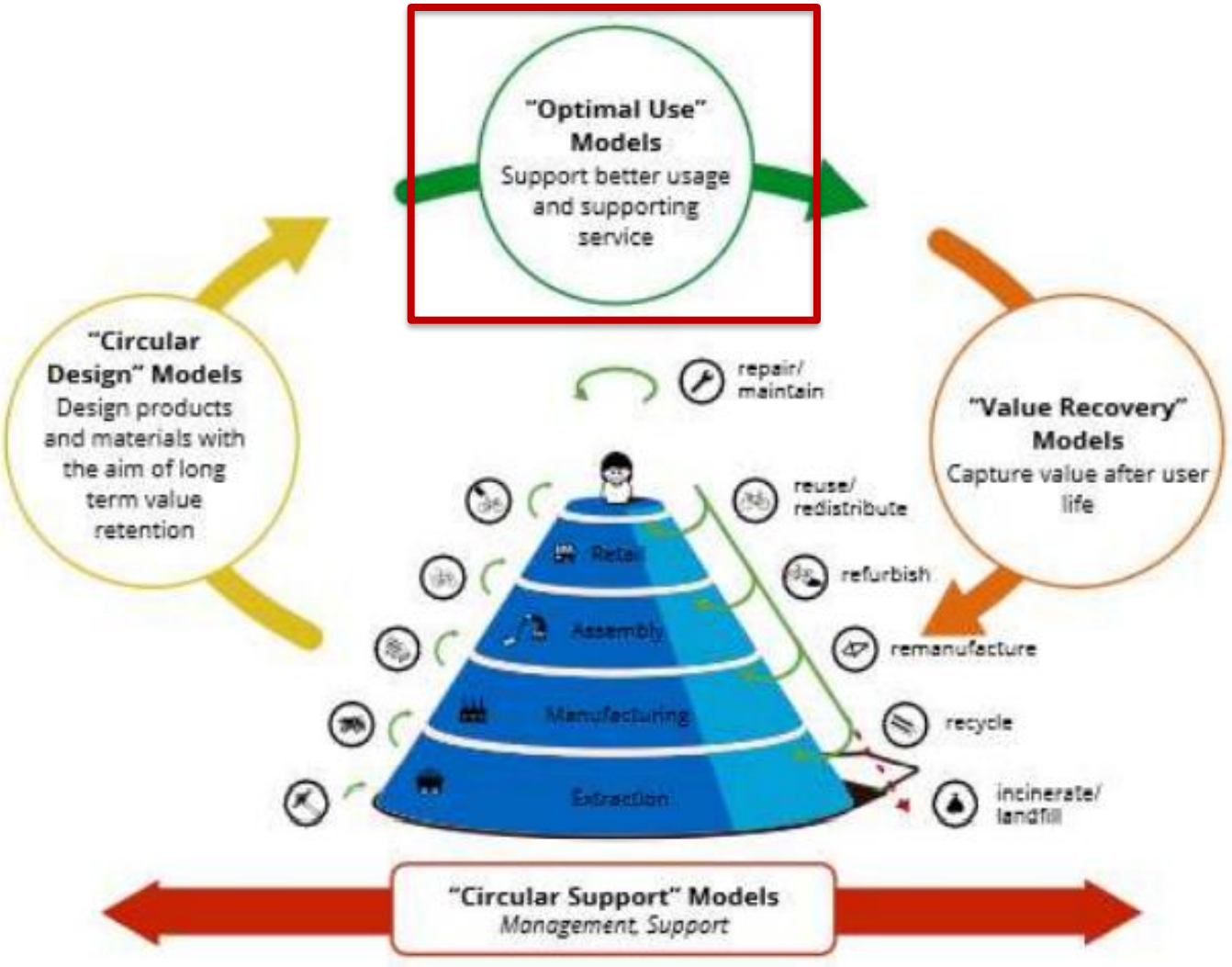
Categorisation systems: circular design and production

Activities contributing to Circular Design and Production aim at increasing resource efficiency through (i) design innovation, (ii) process innovation and reengineering and/or (iii) material innovation and substitution. While such interventions take place early in the product lifecycle, their positive environmental impacts mostly materialise in the use and after-use phases and through reduced use of virgin materials. The following circular activity categories / project types substantially contribute to circular design and production in cases where they apply circular economy (9 R's) strategies listed above and comply with the specific circularity criteria listed below.

Circular categories	Specific circularity criteria	Guidance
1.a Design and production of products and assets that enable circular economy strategies through e.g. (i) increased resource efficiency, durability, functionality, modularity, upgradability, easy disassembly and repair; (ii) use of materials that are reusable, recyclable or compostable. 1.b Development and deployment of process technologies that enable circular economy strategies 1.c Development and sustainable production of new materials (including bio-based materials) that are reusable, recyclable or compostable 1.d Substitution or substantial reduction of substances of concern in materials, products and assets to enable circular economy strategies 1.e Substitution of virgin materials with secondary raw materials and by-products	For activities under the circular categories 1.a, 1.b, 1 c and 1.d to substantially contribute to a circular economy, they must demonstrate that: 1. the activity results in significant overall net resource savings and impact reductions as compared to a benchmark material/product/asset/process that meets the current EU or international industry standards AND 2. the activity supports or enables circular value retention or recovery strategies (R4 – R9) AND 3. the materials/products/assets produced have comparable or increased quality, properties, technical functionality and application areas as compared to a relevant benchmark that meets the current EU or international industry standards AND 4. bio-based materials used are demonstrably traceable to sustainable biomass production AND (in addition only for circular category 1.e) 1. secondary raw materials used satisfy current EU or international or national industry specific standards and legislation AND 2. secondary raw materials used do not increase safety and health risks for users and the environment throughout value chains.	Term Definitions: - 'Circle economy (9 R's) strategies': see definitions for 'Refuse', 'Rethink', 'Reduce', 'Reuse', 'Repair', 'Refurbish', 'Remanufacture', 'Repurpose', 'Recycle' in the introductory section - 'Circular value retention and recovery (R4-R9) strategies': see definitions for 'Reuse', 'Repair', 'Refurbish', 'Remanufacture', 'Repurpose', 'Recycle' in the introductory section - 'Bio-based material': material of biological origin excluding material embedded in geological formations and/or fossilised - 'Compostable' means biodegradable in conformity with the criteria set out in the European standard EN 13432.2000 or equivalent standard - 'Substance of concern' means any substance, other than the active substance, which has an inherent capacity to cause an adverse effect, immediately or in the more distant future, on humans, in particular vulnerable groups, animals or the environment and is present or is produced in a biocidal product in sufficient concentration to present risks of such an effect (as defined in EU BPR 528/2012/EC) - 'Secondary raw materials' are recycled materials/substances that meet end-of-waste criteria as defined in the Directive 2008/98/E on waste - 'By-product' means a substance or object, resulting from a production process, the primary aim of which is not the production of that item, and does not constitute waste (as defined in Directive 2008/98/E on waste) Examples of typical investments/projects: - RDI programmes and infrastructure, including pilot and demonstration facilities, enabling activities under circularity categories 1.a, b, c, d, e - Scale-up and deployment of new technology and/or facilities at commercial scale supporting activities under circularity categories 1.a, b, c, d, e - Design and construction of new buildings and infrastructure incorporating circular products, materials (including recycled materials), construction processes and technologies including circular categories 1.a, b, c, d, e Metrics and verification methods (related to circularity criteria) Besides activity or product specific Lifecycle Assessments (simplified to the extent pertinent), other methods such as Environmental Product Declarations or Eco-design / Circular Economy Certifications can demonstrate net resource savings and impact reductions.

Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: the starting point



Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: circular use

Group 2 - Circular Use Models:

2.a Reuse, repair, refurbishing, repurposing and remanufacturing of end-of-life or redundant products, movable assets and their components that would otherwise be discarded

2.b Refurbishment and repurposing of end-of-design life or redundant immovable assets (buildings/infrastructure/facilities)

2.c Product-as-a-service, reuse and sharing models based on, inter alia, leasing, pay-per-use, subscription or deposit return schemes, that enable circular economy strategies

2.d Rehabilitation of degraded land to return to useful state and remediation of abandoned or underutilised brownfield sites in preparation for redevelopment

Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: circular use

Activities contributing to Circular Use aim at increasing resource efficiency through (i) product and asset lifecycle extension based on reuse, repair, repurposing, refurbishment or remanufacturing strategies and/or (ii) product and asset use-optimizing leasing and sharing models. Such interventions typically take place during or at the end of the use phase of products and assets. The following circular activity categories / project types substantially contribute to circular use in cases where they apply circular economy (9 R's) strategies listed above and comply with the specific circularity criteria listed below.

Circular categories	Specific circularity criteria	Guidance
2.a Reuse, repair, refurbishing, repurposing and remanufacturing of end-of-life or redundant products, movable assets and their components that would otherwise be discarded	For activities under circular category 2.a to substantially contribute to a circular economy, they must demonstrate that: 1. the products/movable assets would otherwise be redundant and discarded AND 2. the activity achieves significant overall net resource savings and impact reductions, on a lifecycle basis, compared to a new, replacement product/movable asset that meets the current EU or international industry standards AND 3. the products/movable assets are put back to their original use possibly with extended properties, or in case they have outlived their original purpose, to an adaptive re-use (by repurposing) AND 4. efforts made to promote the life extension will not compromise the ability to recover or recycle the products/movable assets or their associated materials at the end of a new life-cycle AND, specifically for refurbishment and remanufacturing: 5. refurbished/remanufactured products/movable assets meet a generally accepted specific EU or international, national industry specific standard (as new condition in the case of remanufactured products/assets) and accompanied by relevant warranties for the refurbished assets, as well as materials used, with warranty periods in accordance with legal requirements.	Term Definitions: 'Reuse', 'Repair', 'Refurbish', 'Remanufacture', 'Repurpose': see definitions in the introductory section Examples of typical investments/projects - Refurbishment, retrofitting and remanufacturing of end-of-life or redundant products/movable assets - Construction, expansion or retrofitting of manufacturing facilities, ancillary equipment and technology for refurbishing and remanufacturing purposes - Establishment of small scale businesses or not-for profit organisations for the reuse and repair of consumer products (e.g. clothing, furniture, bicycles, household appliances)

Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: circular use

Circular categories	Specific circularity criteria	Guidance
2.b. Refurbishment and repurposing of end-of-design life or redundant immovable assets (buildings/infrastructure/facilities)	For activities in circular category 2.b to substantially contribute to the circular economy, they must demonstrate that: 1. the activity is deliberately circular by design; meaning that it prioritises strategies that prioritise resource efficiency gains, while simultaneously promoting other objectives such as increasing energy efficiency and/or the quality/resilience of the immovable asset (see guidance section on the right) AND 2. the activity achieves significant overall net resource savings and impact reductions, on a lifecycle basis, compared to a replacement new immovable asset (building/infrastructure/facilities) that meets the current EU or international industry standards AND 3. the buildings/infrastructure/facilities are put back to their original use, possibly with extended functionalities, or in case they have outlived their original purpose, to an adaptive re-use (by repurposing) AND 4. a plan is put in place to enhance the reuse and recycling of materials and components removed during the intervention AND 5. efforts to promote the life extension will not compromise the ability to disassemble the immovable assets (buildings/infrastructure/facilities) and reuse/recycle their associated materials at the end of life, in line with category 3.b AND 6. warranties are provided for the refurbished assets as well as the materials and products used with warranty periods in accordance with legal requirements AND 7. the activity does not contradict current EU or international spatial/urban planning standards, whereby the use of the land for other developments takes precedence.	Term Definitions: - Refurbish, Repurpose, see definitions in the introductory section Generic Guidance: - Typical projects/investments may involve public, residential, commercial or industrial buildings for instance: o refurbishment (including retrofitting) of end of design life or abandoned/unoccupied residential buildings for the purpose of putting them back to useful state as residential buildings o refurbishment (including retrofitting) of abandoned/unoccupied commercial or industrial buildings and facilities, putting them back in use with the same or different purpose, including residential - The criteria listed for circular category 2.b are distinct for "circular" refurbishments/retrofits of immovable assets, which clearly differ from refurbishments aimed at increasing quality/resilience or energy efficiency of the immovable asset. All listed criteria need to be met cumulatively for a refurbishment/retrofit project as a whole to count towards the circular economy - Where a building, facility or infrastructure refurbishment/retrofit project as a whole does not meet criterion 1 and/or 2 (e.g. it predominantly focuses on increasing energy efficiency or the quality/resilience of an immovable asset), any of the following project components may count individually as investments contributing towards the circular economy: o circular design/construction enabling easy disassembly, reuse, repair and/or recycling including through the use of construction materials that are reusable, recyclable or compostable (see categories 1a, 1c, 1d) o use of re-used and/or recycled materials and components in construction (see category 1e) o additional investment for implementation of product-as-service solutions for selected building components (see category 2d) o equipment and technology for harvesting rainwater and recycling/reuse of greywater for water supply in the building (see category 3d) o equipment and technology for on-site blackwater treatment for nutrient recovery (see category 3c) o equipment and technology for on-site high quality fertiliser/compost production for use in gardening (see category 3c) o selective deconstruction of building components, sorting and refinement of construction and demolition waste to facilitate recycling (see category 3a) o creation of a material passport / inventory for the refurbished object (see category 4a)

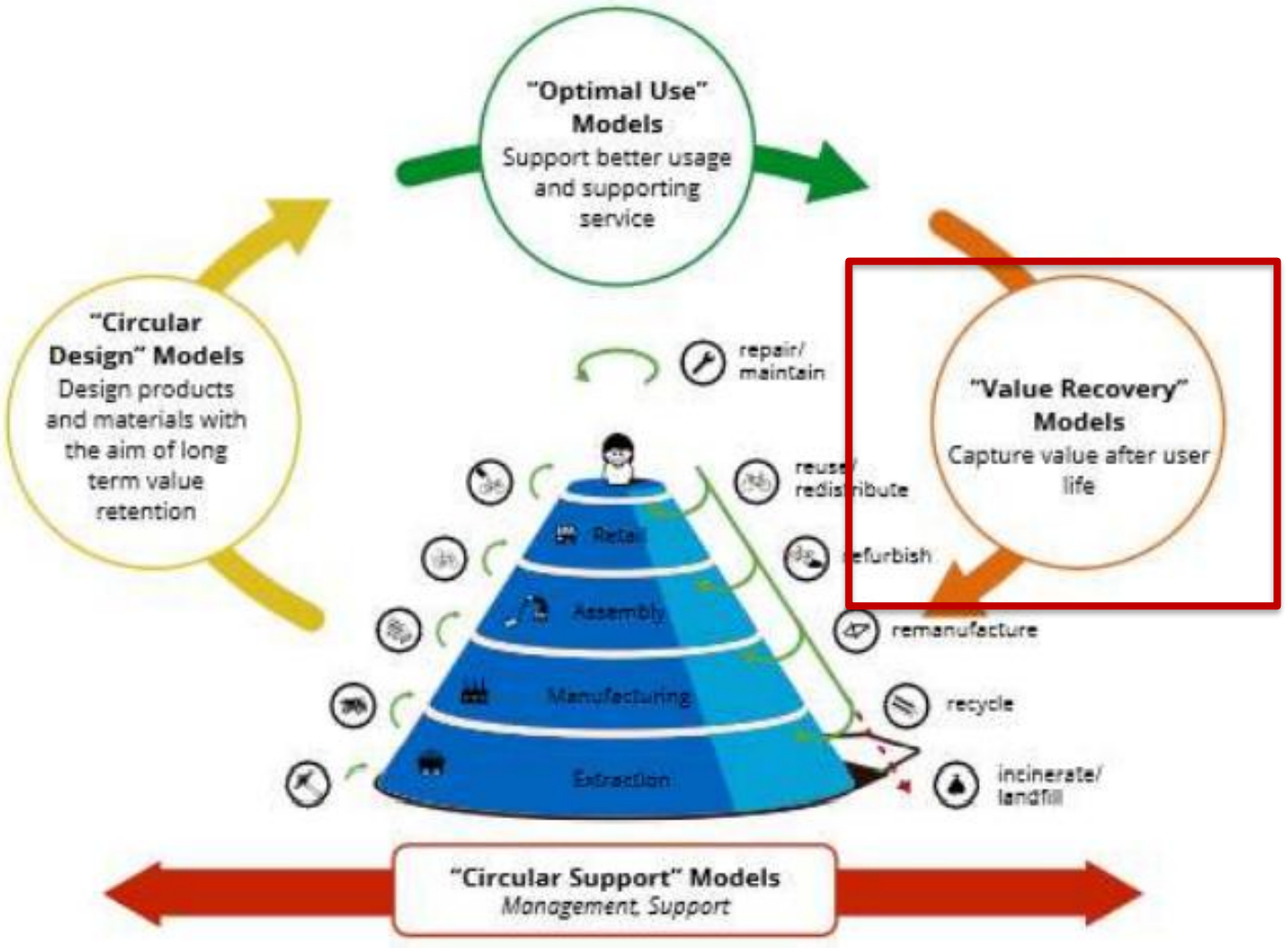
Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: circular use

Circular categories	Specific circularity criteria	Guidance
2.c Product-as-a-service, reuse and sharing models based on, inter alia, leasing, pay-per-use, subscription or deposit return schemes, that enable circular economy strategies	For activities in circular category 2.c to substantially contribute to the circular economy, they must demonstrate that: 1. the contractual model shows that the entity carrying out the activity retains responsibility for the upkeep, maintenance and end-of-life management of the product AND 2. the business model enables circular economy strategies AND 3. the activity increases the overall resource efficiency of the product or asset, on a lifecycle basis, as compared to existing use practice.	Term definitions: - 'Circle economy (9 R's) strategies': see definitions for 'Refuse', 'Rethink', 'Reduce', 'Reuse', 'Repair', 'Refurbish', 'Remanufacture', 'Repurpose', 'Recycle' in the introductory section - Product-as-a-service (PaaS) is a circular economy business model by which a company sells the services and outcomes a product can provide rather than the product itself. Generally, the manufacturer or service-provider continues to own and maintain the product, and the customer leases it for use or subscribes to a menu of services. PaaS can take the form of leasing, sharing and subscription models amongst others. One of the main differences between leasing and sharing is that the typical period of usage for sharing platforms is much shorter. Also, the number of users of assets in a sharing platform is much greater. Subscription models are also similar to leasing but allow for more flexibility, allowing users to access to a wider range of alternative product models which can be used interchangeably on demand, generally for a fixed fee. Truly circular PaaS achieve higher resource efficiency by increasing intensity of use, extending the life of products and ensuring recovery of materials after end-of-life. Moreover, resource efficiency improvements are achieved by avoiding the need for each potential user to buy and own a product, which is then inefficiently used Generic Guidance: PaaS models could pursue product/asset life extension through: (i) leasing products with circular design (e.g. increased durability, modularity, easy disassembly and repair); AND/OR (ii) using predictive maintenance systems aimed at extending the life of the product/asset (e.g. involving intelligent data management and ICT systems); AND/OR (iii) provisions for product/asset return at the end of the first lease lifecycle with subsequent refurbishment/repair to enable re-lease for additional lease lifecycles in "as new" quality condition.
2.d Rehabilitation of degraded land to return to useful state and remediation of abandoned or underutilised brownfield sites in preparation for redevelopment	For activities in circular category 2.d to substantially contribute to the circular economy, they must demonstrate that: 1. the activity is an enabling step for the subsequent reuse/redevelopment of the land (e.g. urban, industrial, agricultural use) AND 2. the activity ensures that remedial targets are protective of natural resources (e.g. water, soils) and human health.	Term definitions: - 'Land degradation' is defined as "the reduction or loss of the biological or economic productivity and complexity of rain fed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns" (from the text of the United Nations Convention to Combat Desertification - UNCCD) - A 'brownfield site' is defined as "previously developed land" that has the potential for being redeveloped. It is often (but not always) land that has been used for industrial and commercial purposes and is now derelict and possibly contaminated with pollutants or hazardous waste - 'Redevelopment' specifically refers to the real estate development process as applied to a site that has already been developed (i.e. built on), which may include the replacement, rehabilitation, or repurposing of existing buildings and infrastructure. Redevelopments may maintain or modify the original use given to the site for residential, commercial or industrial purposes, but also as open spaces for recreation, conservation, woodland and other community areas Generic Guidance: This category applies only to activities aimed at the rehabilitation or remediation of land for subsequent reuse/redevelopment. The refurbishment/repurposing of existing buildings and infrastructure on the site shall qualify as a circular activity where it meets the criteria for circular category 2.b. Replacements with new buildings and infrastructure shall qualify where it meets the criteria for circular category 1.a .

Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: the starting point



Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: circular value recovery

Group 3 - Circular Value Recovery Models:

3.a Separate collection and reverse logistics of wastes as well as redundant products, parts and materials enabling circular value retention and recovery strategies

3.b Recovery of materials from waste in preparation for circular value retention and recovery strategies (excluding feedstock covered under 3.c)

3.c Recovery and valorisation of biomass waste and residues as food, feed, nutrients, fertilisers, bio-based materials or chemical feedstock

3.d Reuse/recycling of wastewater

Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: circular value recovery

Activities contributing to Circular Value Recovery aim at increasing resource efficiency through the recovery of wastes in preparation for reuse and recycling or other circular economy strategies. Such interventions typically take place during the after-use phase of products and assets. The following circular activity categories / project types substantially contribute to circular value recovery in cases where they apply circular economy strategies and comply with the specific circularity criteria listed below.

Circular categories	Specific circularity criteria	Guidance
3.a Separate collection and reverse logistics of wastes as well as redundant products, parts and materials enabling circular value retention and recovery strategies	For activities in circular category 3.a to substantially contribute to the circular economy, they must demonstrate that : 1. wastes, redundant products, parts and materials are collected and transported separately and otherwise managed in a way to enable reuse, repair, refurbishment, remanufacture, high quality recycling and/or valorisation (circular categories 2.a, 3.b and 3.c) AND, in the case of activities involving the collection of wastes: 2. targeted communication and education programs to sensitise waste producers about the importance of waste prevention and segregation are an integral part of the activity.	Term definitions: - Circular value retention and recovery (R4 – R9) strategies' see definitions for 'Reuse', 'Repair', 'Refurbish', 'Remanufacture', 'Repurpose', 'Recycle' in the introductory section - 'Reverse logistics' are generally defined as supply chains dedicated to the reverse flow of redundant or discarded products and materials for the purpose of returns, repair, remanufacture, and/or recycling (as defined by APICS, https://www.apics.org) - The 'collection of wastes' are regulated services provided by specialised operators under public or private service contracts to households and businesses for the safe and efficient management and treatment of wastes. Separate collection schemes target both recyclable wastes and bio-wastes intended for subsequent material recovery and recycling operation - 'Waste' means any substance or object which the holder discards or intends or is required to discard (as defined in EU Directive 2008/98/EC on waste - 'Redundant product, part or material' means a product, part or material that is no longer needed or useful by its holder but suitable for reuse (i.e. possibly after repair, refurbishment or remanufacturing). See definitions for reuse, repair, refurbishment and remanufacturing in the introductory section Examples of typical investments/projects for reverse logistics systems: - Any physical equipment, transport and building infrastructure needed to organise the take back and reverse flow of products and materials to relevant facilities for repair, refurbishing, remanufacturing or recycling Examples of typical investments/projects for separate waste collection: - Movable equipment (bins, containers) - Waste collection and transport vehicles - Supporting infrastructure for waste collection, transport and temporary storage (e.g. civic amenity centres, transfer and reloading stations, vehicle depots, facilities for refuelling/recharging, washing, maintenance and repair)

Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: circular value recovery

Circular categories	Specific circularity criteria	Guidance
3.b Recovery of materials from waste in preparation for circular value retention and recovery strategies (excluding feedstock covered under 3.c)	For activities in circular category 3.b to substantially contribute to the circular economy, they must demonstrate that: 1. the feedstock constitutes or originates from source segregated and separately collected waste fractions AND 2. the activity contributes to attaining material recovery rates that are aligned with targets established for relevant waste types in EU or national law as well as in local waste management plans; and collaborates with other actors in the value chain to increase the quality of recovered materials to the extent that is both technically feasible and economically viable AND 3. secondary raw materials as well as product parts recovered are suitable for reuse or recycling and meet relevant EU or international or national industry specific regulations, standards and/or user specifications AND 4. the management of residues from the recovery process shall follow the EU waste hierarchy principle.	Term definitions: - "Circular value retention and recovery (R4 – R9) strategies' see definitions for 'Reuse', 'Repair', 'Refurbish', 'Remanufacture', 'Repurpose', 'Recycle' in the introductory section - 'Waste' means any substance or object which the holder discards or intends or is required to discard (as defined in EU WFD 2008/98/EC) - 'Material recovery' means any recovery operation, other than energy recovery and the reprocessing into materials that are to be used as fuels or other means to generate energy. It includes, inter alia, preparing for reuse, recycling and backfilling (as defined in EU WFD 2018/851) Examples of typical investments/projects: - Material recovery facilities (MRF), process technology and mobile equipment, involving manual, semi-automated and/or fully automated mechanical processes (dismantling, separation, sorting, crushing, shredding, cutting, post-treatment technologies, etc.) - Chemical recycling plants involving various types of technologies and processes (e.g. depolymerisation, solvolysis, gasification, pyrolysis, etc) Note that specific criteria may need to be further developed for different material recovery/recycling technologies, to take into account their individual recovery performance and environmental impacts on a lifecycle basis. On the matter, see for instance the study on chemical recycling by CE Delft (https://www.cedelft.eu/en/publications/2173/exploratory-study-on-chemical-recycling-update-2019).

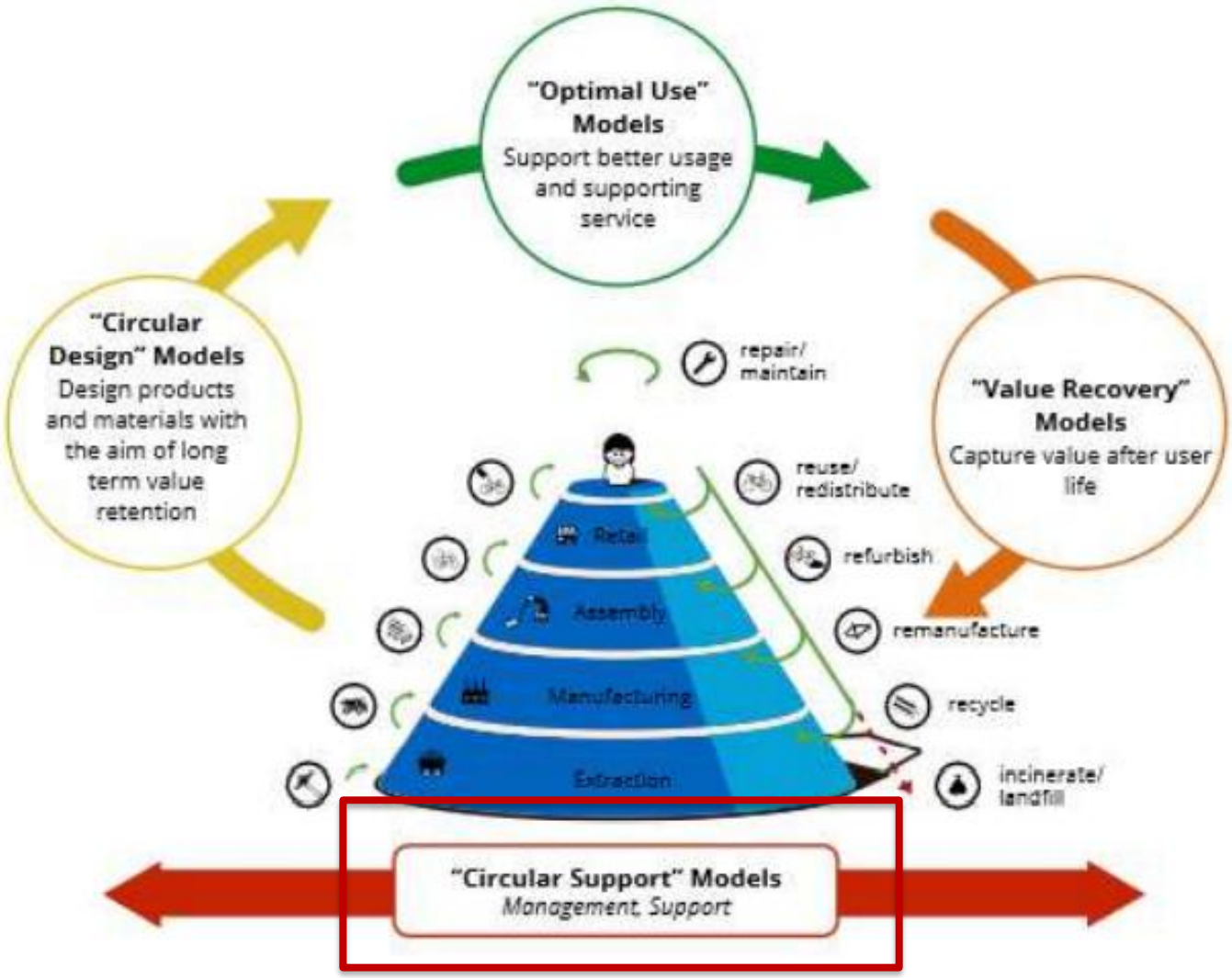
Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: circular value recovery

Circular categories	Specific circularity criteria	Guidance
3.c Recovery and valorisation of biomass waste and residues as food, feed, nutrients, fertilisers, bio-based materials or chemical feedstock	For activities in circular category 3.c to substantially contribute to the circular economy, they must demonstrate that: 1. the feedstock constitutes or originates from non-hazardous source segregated and separately collected biomass waste and residues, i.e. these are not separated from mixed residual waste AND 2. the recovery process seeks to give the highest possible economic use to the feedstock, subject to technical and economic viability AND 3. the products from the recovery/valorisation process meet relevant EU or international, national industry specific regulations and legislation, standards and/or user specifications for the intended use AND 4. material recovery and valorisation is a primary objective of the recovery process. By-products and residues from the primary recovery process are diverted to further recovery operations with the intention to maximise total value recovery in accordance with the EU waste hierarchy principle, where technically and economically viable AND 5. energetic use of by-products and residues of the recovery process is allowed to cover own energy needs or where there is no other economically viable higher use for these AND specifically for processes that divert (i) crops residues (e.g. straw, corn stover, etc.), (ii) animal by-products (e.g. slurry, manure, etc.) or (iii) forest residues (e.g. small trees, branches, tops and un-merchantable wood left in the forest after the cleaning, thinning or final felling of forest stands) from their standard use in the agricultural / forest cycles for use as feedstock … 6. the allowed biomass extraction levels should be determined on a case-by-case basis, factoring in pedo-climatic conditions, to avoid any depletion to soil fertility. If certain by-products (e.g. digestates, ashes, nutrients (N-P-K-S and other minerals), organic matter, etc.) are incorporated back to agricultural / forest soils while satisfying to relevant EU or other international, national industry specific standards as well as user specifications, the maximum allowance levels could be adjusted.	Term definitions: 'Biomass waste and residues' is any type of biodegradable waste or residue from municipal, commercial, industrial or agricultural sources. This includes, inter alia: o 'bio-waste' as defined in EU Directive 2008/98/EC, which means biodegradable garden and park waste, food and kitchen waste from households, offices, restaurants, wholesale, canteens, caterers and retail premises and comparable waste from food processing plants o organic by-products directly deriving from or generated by agriculture (agricultural crop residues, e.g. straw, bagasse, husks), aquaculture, fisheries and forestry as well as from related industries and processing o 'organic sludge' meaning residual, semi-solid material that is produced as a by-product during treatment of industrial or municipal wastewater Examples of typical investments/projects: - Biorefinery facilities and process technology for the extraction of bio-based products and feedstock from bio-wastes and residual biomass, wastewater and sludge from organic origin - Anaerobic digestion and composting plants utilizing the resulting digestates/composts as fertilisers/soil conditioners
3.d Reuse/recycling of wastewater	For activities in circular category 3.d to substantially contribute to the circular economy, they must demonstrate that: 1. it satisfies EU legal provisions or recognised international standards and user specifications for reused/recycled wastewater AND 2. it does not increase pollution, safety and health risks for users and the environment AND 3. appropriate technical measures and/or economic instruments are in place or planned to improve resource efficiency in the overall water use cycle, subject to technical and economic viability.	Examples of typical investments/projects: - Equipment and technology to collect treat and distribute wastewater in order to reuse it for household, industrial or agriculture purposes instead of discharging it For the sake of clarity, only the additional investment cost related to the objective of reusing the wastewater is included. Not the mandatory onsite treatment of wastewater.

Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: the starting point



Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: circular support

Group 4 - Circular Support

4.a Development/deployment of tools, applications, and services enabling circular economy strategies

Source: Categorisation system for the circular economy (European Commission, 2020)

Categorisation systems: circular support

Circular categories	Specific circularity criteria	Guidance
Activities in the Circular Support category group aim at enabling other circular activities/projects and thus indirectly contribute to increasing resource efficiency. The following circular activity categories / project types substantially contribute to the circular economy in cases where they apply or enable circular economy (9 R's) strategies listed above and meet the specific circularity criteria listed below.		
4.a Development/deployment of tools, applications, and services enabling circular economy strategies	For activities in circular category 4.a to substantially contribute to the circular economy, they must demonstrate that: 1. the circular support tools, applications and services demonstrably enable circular economy strategies and result in significant overall net resource savings.	Term definitions: - 'Circle economy (9 R's) strategies': see definitions for 'Refuse', 'Rethink', 'Reduce', 'Reuse', 'Repair', 'Refurbish', 'Remanufacture', 'Repurpose', 'Recycle' in the introductory section Examples of typical investments/projects: - ICT tools for predictive maintenance and repair to extend the life of products - Digital tools and applications to facilitate reverse logistics (tracking, take-back of products for reuse, repair or recycling), improve resource efficiency and avoidance of waste production (e.g. food waste in restaurants, shops) - Virtual marketplaces for secondary raw materials or second hand/repaired/upgraded products - Digital material passports and related data repositories to facilitate the tracing, marketing and trade of secondary raw materials in end-of-life products and constructions - Methodological frameworks and tools for measuring and monitoring of progress in the transition to a circular economy - Digital tools and applications for consumer awareness raising/education on the application and benefits of different circular economy strategies - Advisory services to companies and public authorities for strategising, preparing and implementing circular economy transitions

Source: Categorisation system for the circular economy (European Commission, 2020)