

CAPIEL^{*}

european coordinating committee of manufacturers
of electrical switchgear and controlgear

CAPIEL White Paper on **Circular Economy**

March 1st, 2024

Table of contents

Introduction.....	3
Content.....	4
Vision	4
Position.....	5
Aspects of Circular Economy	6-16
Raw and Recycled Materials	7
Design.....	7
Production / Remanufacturing.....	9
Distribution (delivery).....	10
Use phase	11
Collection	14
Recycling/ Recovery.....	14

CAPIEL White Paper on Circular Economy

Executive summary

In order to address the environmental concept of climate neutrality, organisations around the world are developing regulations and standards, and CAPIEL is committed to being a leader on this topic.

An important aspect of climate neutrality is the topic of **Circular Economy**.

In this paper, CAPIEL experts explain important terms and definitions and provide a common understanding of relevant aspects of Circular Economy in the context of switchgear and controlgear and their assemblies to help implement more green actions in the industrial automation business.

Introduction

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership (<https://sdgs.un.org/goals>).

The climate crisis has increased the demand for sustainable products and there is an increasing push from Global, European and National legislators for more 'circular' products, through regulation and standardization like the European Green Deal and its Circular economy action plan (https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en#objectives) or the Green Design Standardization in China. CAPIEL wholeheartedly supports such initiatives.

Switchgear & Controlgear devices by necessity, are very reliable and durable industrial products and typically have a lifecycle of 20 – 30 years. They are re-usable and normally incorporated in modular assemblies which facilitates maintainability and repairability.

The EN 4555X series of standards has been developed to provide a framework to support the **Ecodesign for Sustainable Product Regulation (ESPR)** requirements relating to

WHITE PAPER

aspects including recyclability, remanufacturing, repairability, reusability, upgradability, recoverability, or durability of products. This series comprises eight standards and provides common definitions and calculation methods for the above-mentioned material efficiency aspects of the circular economy.

This paper describes the actions that CAPIEL members are taking to meet these Circular Economy objectives.

Content

Product Specific Rules (PSR) for Low voltage switchgear and controlgear (LVSG) are set out in IEC 63058. This allows manufacturers to evaluate the environmental impact of their products throughout the entire Life Cycle, and to enable effective communication of environmental information such as CO₂ footprint.

The CAPIEL paper gives valuable information to LVSG manufacturers and customers concerning the application of the Circular Economy aspects.

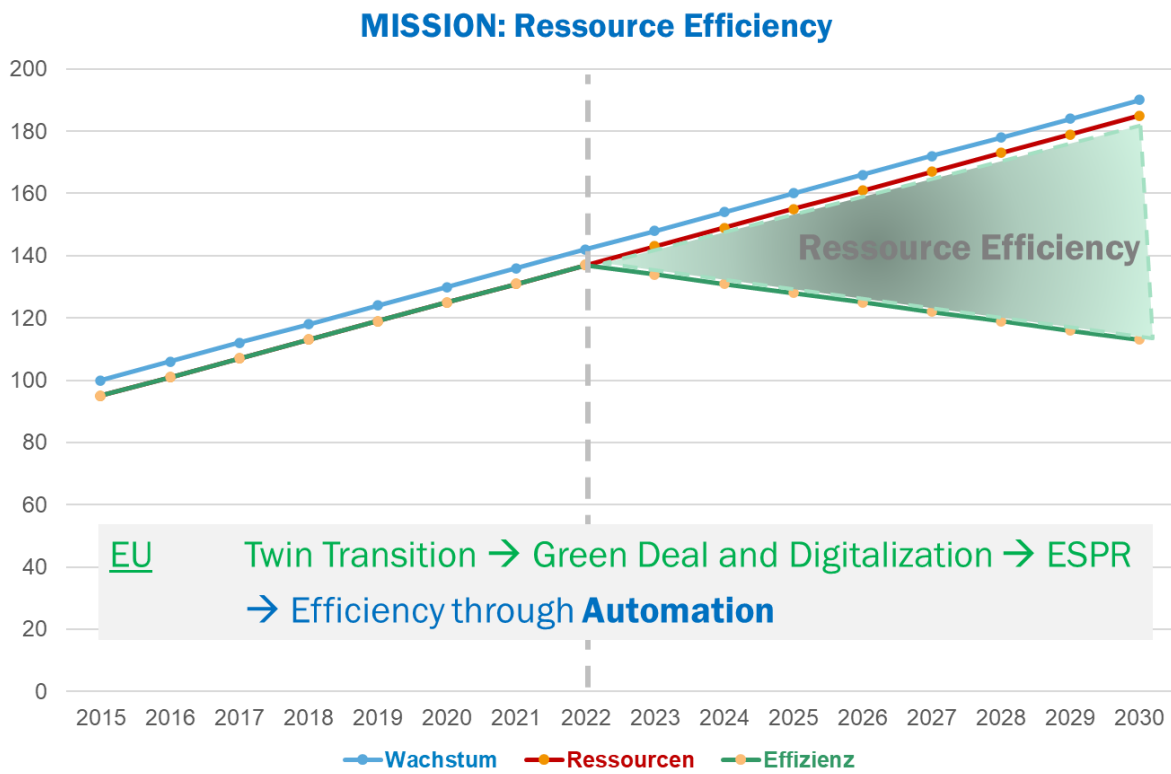
Vision

CAPIEL is convinced that electrification is enabling the migration to non-harmful, decarbonised and sustainable economy growth towards circular economy. In that respect, CAPIEL has the mission to help the market to become carbon-neutral and sustainable.

Thanks to the megatrend of digitalisation, CAPIEL products with connectivity, sensors everywhere are bringing intelligence in an open and connected ecosystem. This allows a high level of resource efficiency through automation, especially the:

- Reduction of the use of the energy and raw material through the optimised control of the loads
- Remote access at any time from anywhere
- Monitoring of events limiting unplanned downtime
- Interoperability between systems allowing smooth process interactions.

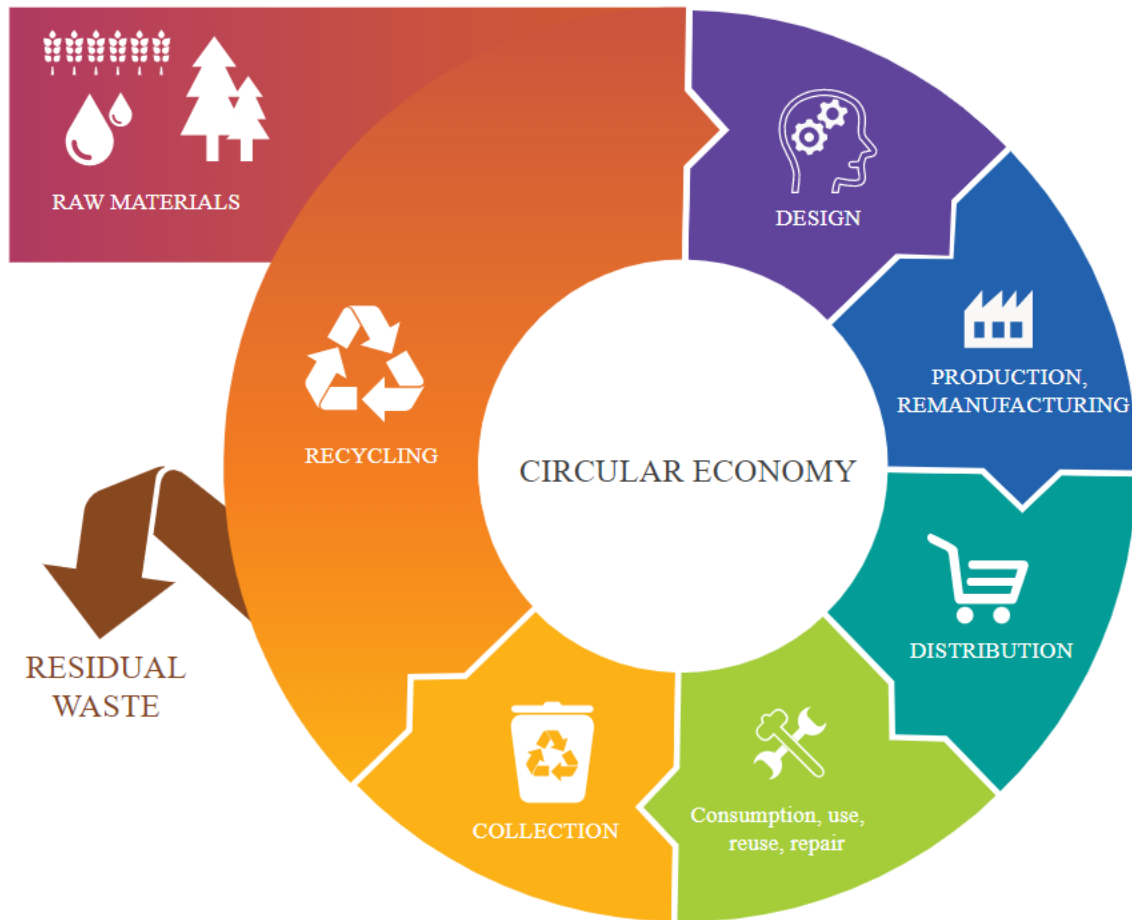
WHITE PAPER



Position

The priority of CAPIEL manufacturers is the continuous improvement of the process of environmentally conscious design (ECD) of the products. This process focuses on the correlation between the principal steps in the environmental life cycle of a product, the product's function, its design and performance. The major objectives of this process are the consumption of material and energy, environmental emissions, recyclability, and end-of-life instructions.

Aspects of Circular Economy



WHITE PAPER

Raw and Recycled Materials

The ultimate goal is to avoid using "new" raw material (*primary material*) and instead use *recycled material*. The extent of saving depends on all aspects of "Circular Economy".

RAW MATERIALS
RECYCLING 



For CAPIEL, it is important to utilize secondary materials with appropriate technical quality (product data) in a necessary amount and reasonable costs. This requires appropriate product and environmental data.

The large number of existing databases must be consolidated. CAPIEL uses databases according to IEC 63058.

EN 45557 "primary material"

Material made from virgin raw material(s).

EN 45557 "recycled material"

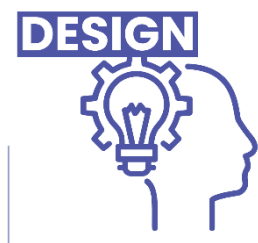
Material which is either pre-consumer material or post-consumer material.

Note 1 to entry: the terms "recycled material" and "secondary material" have the same meaning in EN 45557.

Design

The design should consider the following aspects:

- Design with as much *recycled material* as possible (Material demand by design) and *primary material* shall only be used if technically necessary
- Design for *durability* (by enabling repair, refurbish and upgrade) and *reparability* (disassembly / reprocessing) and good *recyclability*
- Low energy consumption in production and low intrinsic energy consumption in the use phase
- Design products for a good *reliability*



WHITE PAPER

EN 45552 “durability”

Durability ability to function as required, under defined conditions of use, maintenance and repair, until a limiting state is reached.

Note 1 to entry: The degree to which maintenance and repair are within the scope of durability will vary by product or product-group.

Note 2 to entry: The user of EN 45552:2020 has to define the criteria for the transition from limiting state to end-of-life (EoL). For more information see Figure D.1 in EN 45552:2020.

Note 3 to entry: Durability can be expressed in units appropriate to the part or product concerned, e.g., calendar time, operating cycles, distance run, etc. The units should always be clearly stated.

EN 45552 “reliability”

Probability that a product functions as required under given conditions, including maintenance, for a given duration without limiting event.

Note 1 to entry: The intended function(s) and given conditions are described in the information for use provided with the product.

Note 2 to entry: Duration can be expressed in units appropriate to the part or product concerned, e.g., calendar time, operating cycles, distance run, etc. The units should always be clearly stated.

EN 45553 “disassembly”

Process whereby a product is taken apart in such a way that it could subsequently be assembled and made operational.

EN 45553 “reprocessing”

Restoration or modification of the functionality of a product or part.

Note 1 to entry: Reprocessing may consist of repairing, rework, replacement of worn parts, and/or upgrade of soft- firm and/or hardware.

Other keywords:

- Normal use
- Intended use
- Normal operating conditions
- Maintenance
- Normal environmental conditions

EN 45554 “upgrade”

Process of enhancing the functionality, performance, capacity or aesthetics of a product.

Note 1 to entry: An upgrade to a product may involve changes to its software, firmware and/or hardware.

Note 2 to entry: Refer to the “Blue Guide” [3] for conditions under which a product is considered as a new product when placing it on the market after upgrading it.

WHITE PAPER

Production / Remanufacturing

Minimise the following:

- Energy for production
- Use of auxiliary materials (oils, solder, compressed air, electroplating, ...)
- use of transport, material handling and storage
- waste (injection molding sprue, punching waste)
- Emissions during the production process
- distributed manufacturing

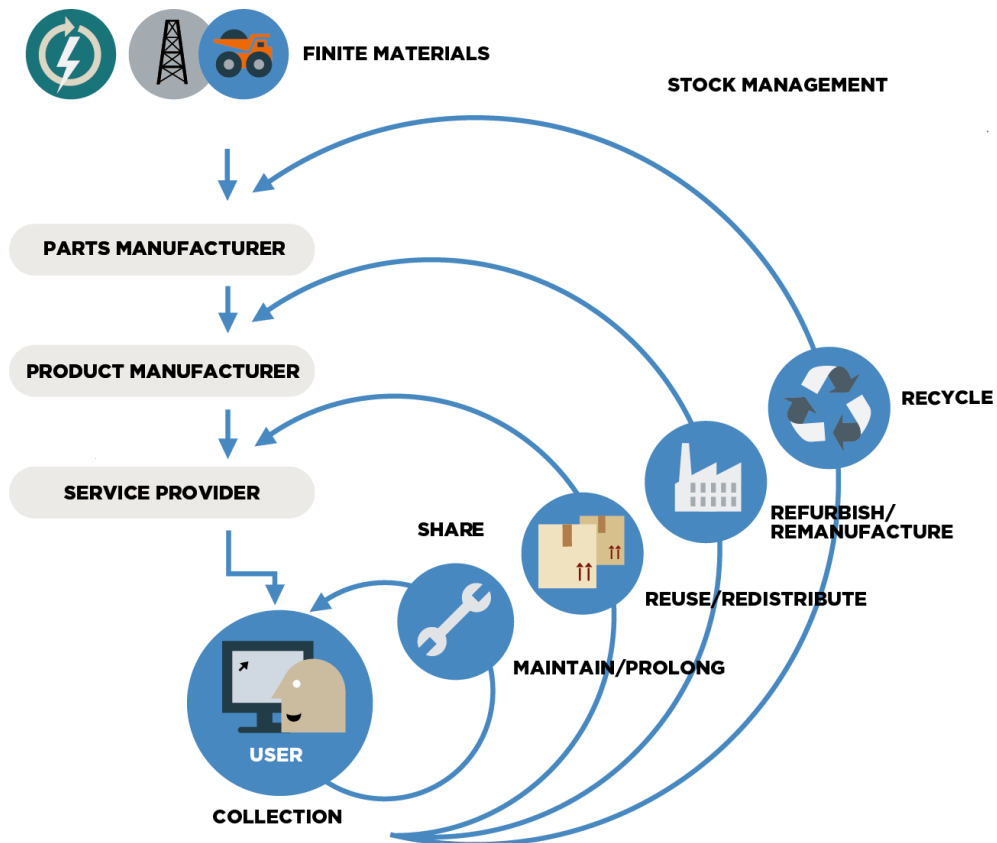
PRODUCTION, REMANUFACTURING



We assume that the products are manufactured worldwide with appropriate licenses in compliance with regional environmental requirements. CAPIEL companies have their own responsibility of ethical, social and environmental aspects beyond.

Refurbish/Remanufacturing may be possible for some CAPIEL products in the future.

The following figure shows the relation of refurbishment within the Use-phase.



WHITE PAPER

remanufacture (IEV 904-04-10)

Production process that creates products using parts taken from previously used products.

EN 45553 “remanufacturing” (remanufacturing ≠ reuse of parts for the same product → in this case refurbishing is the right term)

Industrial process which produces a product from used products or used parts where at least one change is made which influences the safety, original performance, purpose or type of the product.

Note 1 to entry: The product created by the remanufacturing process may be considered a new product when placing on the market. Refer to the EU Blue Guide [1] for additional information.

Note 2 to entry: Refurbishing is a similar concept to remanufacturing except that it does not involve changes influencing safety, original performance, purpose or type of the product. It is not covered by EN 45553:2020.

EN 45557 “pre-consumer material”

Material diverted from the waste generated during a manufacturing process excluding reutilization of materials such as rework, regrind or scrap generated in a process and being reincorporated in the same process that generated it.

Note 1 to entry: Same process means the same manufacturing operation for the same type of product in the same or different physical location.

refurbishing (IEV 904-04-09)

Functional or aesthetical maintenance or repair of an item to restore to original, upgraded, or other predetermined form and functionality.

Distribution (delivery)

According to Product Specific Rule (PSR according to IEC 63058) governing the process of developing environmental product declarations (EPD) based on lifecycle assessments (LCA), the distribution phase of the lifecycle of Electrical, Electronic and HVAC-R Products includes the transportation from the last manufacturer's logistics platform to the arrival of the product at the location of use and production of reconditioning packaging at the manufacturer's site.

DISTRIBUTION



The PSR requires that the inputs and outputs associated with the following aspects shall be included in the distribution stage:

1. Transportation of the product in its packaging from the manufacturer's last logistics platform to the distributor and from the distributor to the installation place.

WHITE PAPER

2. Where appropriate, production, procurement and transportation of reconditioning packaging materials:
 - Production (extraction, treatment, transformation, etc.) of raw materials and procurement of the reconditioning packaging,
 - Transportation of the reconditioning packaging from the point of reconditioning to the location of use.
3. Where appropriate, end-of-life management of the product packaging materials leaving the last logistic platform up to their end-of-waste status or disposal of the final residues.

Transport-specific data should be taken into account for transportation stages (kilometers covered, types of transport, payload factor). Data shall be justified and documented in the LCA report. If no specific data are available, the data from the IEC 63058 Annex B can be taken.

Use phase

The use phase consists of the following items:

- Energy consumption
- Reuse
- Repair
- Upgrade



Energy consumption

For most of the low-voltage SG&CG, the main potential environmental impacts – e.g. GWP – are dominated by the power losses in the use phase, that depend on the loading conditions. Typical use scenarios including the RLT and the use time rate (in percentage of RLT) are given in the following table.

WHITE PAPER

Typical use scenarios for switchgear and controlgear

Product family	Application	Reference lifetime (RLT) [years]	Use scenario	
			Load rate [% of I_n]	Use time rate [% of RLT]
Circuit-breaker ^b	Low-voltage power distribution	20	50	30
Switch-disconnector	Low-voltage power distribution	20	50	30
Switch	Low-voltage power distribution	20	50	30
Disconnecter	Low-voltage power distribution	20	50	30
Fuse combination unit	Low-voltage power distribution	20	50	30
Transfer switch equipment	Low-voltage power distribution	20	50	15
Arc quenching device ^b	Low-voltage power distribution	20	n.a. ^a	0
Contactors	Control of low-voltage loads	20	50	50
Motor protection switching device	Control of low-voltage motors	20	50	50
Combination motor starter and CPS	Control of low-voltage motors	20	50	50
Soft-starter [by-passed]	Control of low-voltage motors	15	50	50
Semiconductor controller	Control of low-voltage motors	15	50	50
Overload and protection relays	Motor protection	20	50	50
Push-button	Low-voltage user interface	20	10	10
Indicator light/tower	Low-voltage user feedback	15	100	50
Emergency stop device	Low-voltage user interface	20	10	100
Enabling switch	Low-voltage user interface	15	20	30
Position switch	Machinery control	15	20	30
Analog sensor	Machinery control	20	50	100
Proximity switch	Machinery control	20	20	100
Photoelectrical switch	Machinery control	10	20	100
IACD (stand-alone or multifunction type)	Low-voltage power distribution	10	n.a. ^c	100

NOTE Other products families are under consideration.

NOTE 2 The parameters in this table are defined at the normal condition defined in each product standard.

^a Not applicable. AQD are not defined regarding I_n . No reference current rating is required as the load-rate is not relevant for the evaluation of the impact in the use phase.

^b Applies to combined-type IACD as defined by future IEC 60947-9-2.

^c Not applicable. IACD without secondary current sensors are not defined regarding I_n . No reference current rating is required as the load-rate is not relevant for the evaluation of the impact in the use phase.

WHITE PAPER

Reuse

The *reuse* of low-voltage SG&CG parts to manufacture new products is very unlikely. However, for low-voltage SG&CG assemblies, the reuse of LV SG&CG equipment is possible as most of the SG&CG have a useful life greater than 15 years.

In such a case following aspects should be considered:

- Possible trade-off on other environmental aspects (e.g. energy efficiency, durability, ...)
- Warranty and responsibility
- Inspection and Testing (will be probably addressed in the relevant product standards)
- Priorities on components to be recycled: environmental impact (LCA), technical feasibility, ...
- Information about reused components to be provided to the customer
- Software update

Repair

When applicable, the useful life of a LV SG&CG can be extended through repair of the device by replacing predefined parts for which spare parts are available. For some categories of product, the manufacturer can provide a repair service or repair instructions including all safety aspects and verification to be performed after repair, if necessary. For LV SG&CG assemblies the repair by replacing faulty equipment is a common process well established.

Upgrade

Upgrade is the process of enhancing the functionality, performance, capacity or aesthetics of a product. This can be performed by the user himself according to the instruction of the manufacturer, e.g. software, firmware-update. Or the manufacturer can provide this service.

WHITE PAPER

EN 45554 “reuse”

Process by which a product or its parts, having reached the end of their first use, are used for the same purpose for which they were conceived.

Note 1 to entry: Reuse after second or subsequent usage is also considered as reuse, but normal, regular or sporadic use is not considered as reuse.

EN 45554 “repair”

Process of returning a faulty product to a condition where it can fulfil its intended use.

EN 45554 “upgrade”

Process of enhancing the functionality, performance, capacity or aesthetics of a product.

Note 1 to entry: An upgrade to a product may involve changes to its software, firmware and/or hardware.

Note 2 to entry: Refer to the “Blue Guide” [3] for conditions under which a product is considered as a new product when placing it on the market after upgrading it.

Collection

CAPIEL devices will normally be returned via an approved collection scheme for electric or electronic devices. CAPIEL assumes that the end user takes responsibility for returning our devices to the WEEE materials cycle.



CAPIEL devices marked with the crossed-out wheeled bin indicates that they should be collected separately.

Exception: Collection for repair and refurbishment

EN 45555 “[EoL] end-of-life”

Life cycle stage of a product starting when it is removed from its intended use stage.

Note 1 to entry: Within this standard, removal from its intended use phase includes when it has been discarded as waste.

Recycling / Recovery

Specialized companies separate the waste into separate material groups e.g. copper, steel, different kind of plastics like PP, PA. These individual material groups are returned to the material manufacturers, who in turn are suppliers of CAPIEL manufacturers. These suppliers provide CAPIEL manufacturers with certified



WHITE PAPER

materials containing a certain recycled content (*post-consumer material*). This closes the circle (*end-of-life treatment*).

Depending on the kind of material the recycling rate is different, higher for metallic materials and lower for plastics (*recycling*). CAPIEL is working with their suppliers both, to increase that rate, and to bring some materials like thermoset materials into the recycling processes.

However, the technical possibilities do not allow 100% recycling rate. The remaining parts can be used by a downcycling (*recovery*) of their material properties (characteristics) or by *energy recovery*.

Material which cannot be used for downcycling or energy recovery is considered to be *waste* and is *disposed by backfilling*.

EN 45557 “post-consumer material”

Material recovered from waste generated by households or by commercial, industrial and institutional facilities in their role as end-users of a finished product.

Note 1 to entry: This includes returns of products, or parts thereof, from the distribution of finished products for end-users.

EN 45555 “[EoL treatment] end-of-life treatment”

Operation of any kind by which a product is recovered or disposed of.

EN 45555 “recycling” [keeping on same level]

Recovery operation of any kind [exploitation], by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes excluding energy recovery.

Note 1 to entry: Recycling 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.

EN 45555 “recovery” [downgrading]

Operation of any kind [exploitation], the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy.

Note 1 to entry: Annex II of the Waste Framework Directive (2008/98/EC) sets out a non-exhaustive list of recovery operations.

WHITE PAPER

EN 45555 “material recovery”

Recovery operation of any kind, other than energy recovery and the reprocessing into materials that are to be used as fuels or other means to generate energy.

Note 1 to entry: Material recovery includes, inter alia, preparing for reuse, recycling and backfilling.

[SOURCE: Directive 2008/98/EC, modified by moving the last sentence of definition to Note 1 to entry]

EN 45555 “energy recovery”

Production of useful energy through direct and controlled combustion or other processing of waste.

EN 45555 “waste”

Substance or object of any kind, which the holder discards or intends or is required to discard.

EN 45555 “disposal”

operation of any kind, which is not recovery even where the operation has as a secondary consequence the reclamation of substances or energy

Note 1 to entry: Annex I of the Waste Framework Directive (2008/98/EC) sets out a non-exhaustive list of disposal operations.

EN 45555 “backfilling”

Recovery operation of any kind where suitable non-hazardous waste is used for purposes of reclamation in excavated areas or for engineering purposes in landscaping.

Note 1 to entry: Waste used for backfilling must substitute non-waste materials, be suitable for the aforementioned purposes, and be limited to the amount strictly necessary to achieve those purposes.