

Permanent Materials

A new material category

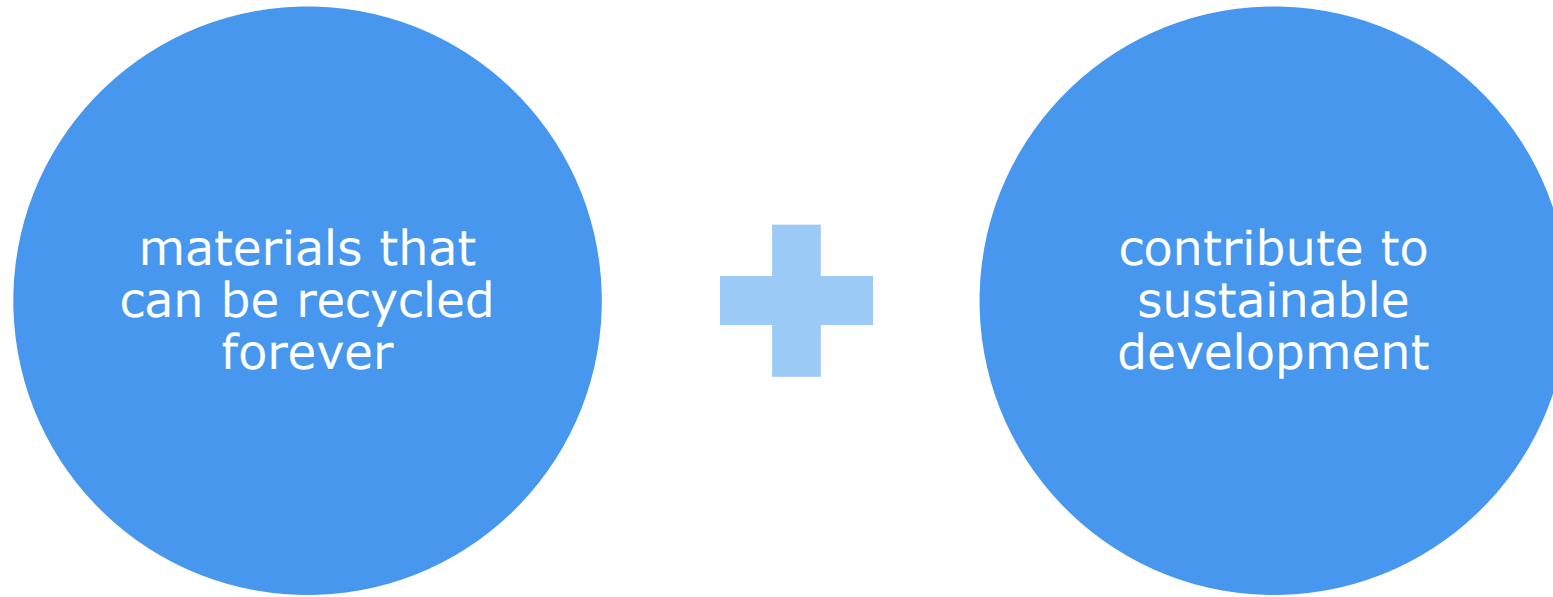


Metal
Packaging
Europe



METAL
recycles
forever

Imagine



The perfect example of a circular economy

Sustainable development

Within the context of sustainable development, the responsible use of material resources is key.

This implies:

- Responsible primary material production →
- Efficient use →

- Reuse and recycling of materials resources →
- Use of permanent / renewable resources →

**VALID FOR ALL
MATERIALS**

**CLASSIFICATION OF
MATERIALS**

Old classification



Non renewable

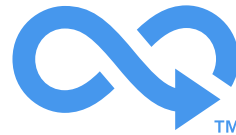


Renewable

New classification



Non renewable



Permanent



Renewable

Back to basics, back to the future

- Over the past 100 years, we have developed ever more complex materials.
- This complexity and diversity has made recycling increasingly challenging.
- **Permanent materials** consist of **robust chemical components** to make multiple recycling possible.
- After use, permanent materials go back to their roots as a raw material for new uses.

Use rather than consume

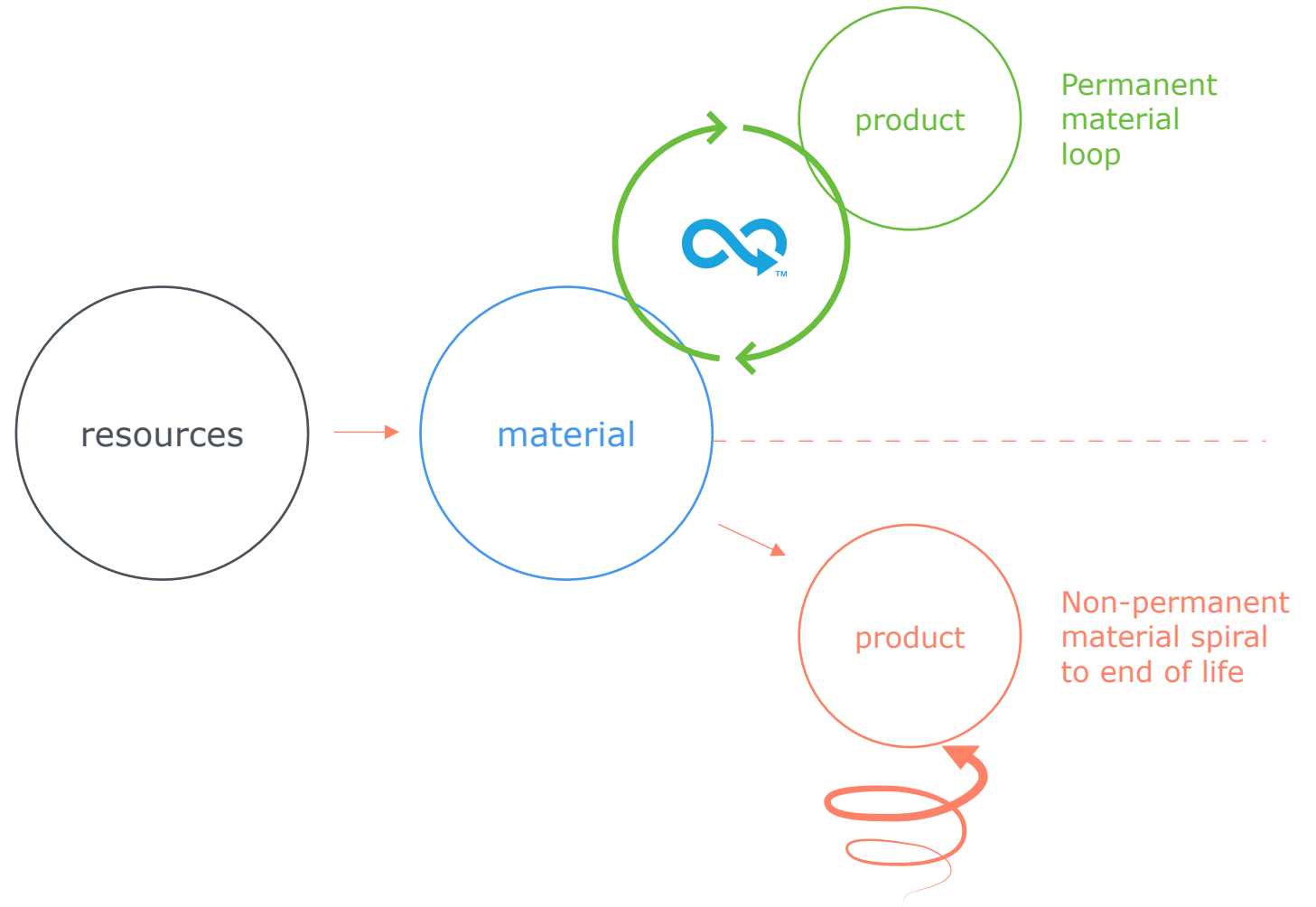
- Permanent materials are not consumed, they are merely used.
- Permanent materials are moved from the ground or manufactured and used in a range of applications and then 'lent' to other applications after their previous use.
- They can be recycled, over and over again, without loss of properties: **multiple recycling**.



Definition

A permanent material is one for which the **inherent properties do not change** during use and regardless of repeated recycling into new products.

Its recycling does not necessarily require the addition of primary material or additives to enable the basic material function / or properties.



Two pillars

The Concept Permanent Materials is based on two pillars

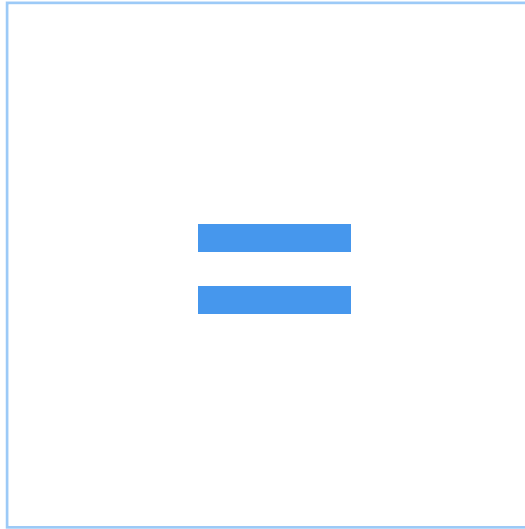


Properties of a permanent material

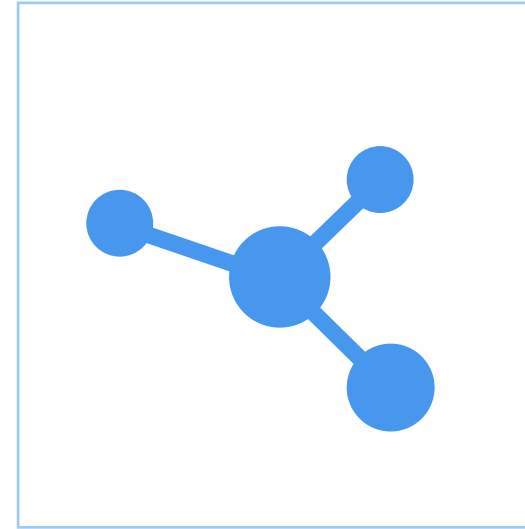
The first pillar of the Concept of Permanent Materials is the **chemical structure**



Inherit properties do not change during use or recycling



Material reverts to its initial state



Consists of basic components:

- Either chemical elements, or
- Robust chemical compounds



It's elementary, my dear Watson

PERIOD	GROUP																			
	1 IA	2 IIA												13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA	
1	H 1.0079 HYDROGEN																			He 4.0026 HELIUM
2	Li 6.941 LITHIUM	Be 9.0122 BERYLLIUM											B 10.811 BORON	C 12.011 CARBON	N 14.007 NITROGEN	O 15.999 OXYGEN	F 18.998 FLUORINE	Ne 20.180 NEON		
3	Na 22.990 SODIUM	Mg 24.305 MAGNESIUM											Al 26.982 ALUMINIUM	Si 28.086 SILICON	P 30.974 PHOSPHORUS	S 32.065 SULPHUR	Cl 35.453 CHLORINE	Ar 39.948 ARGON		
4	K 39.098 POTASSIUM	Ca 40.078 CALCIUM	Sc 44.956 SCANDIUM	Ti 47.867 TITANIUM	V 50.942 VANADIUM	Cr 51.996 CHROMIUM	Mn 54.938 MANGANESE	Fe 55.845 IRON	Co 58.933 COBALT	Ni 58.693 NICKEL	Cu 63.546 COPPER	Zn 65.39 ZINC	Ga 69.723 GALLIUM	Ge 72.64 GERMANIUM	As 74.922 ARSENIC	Se 78.96 SELENIUM	Br 79.904 BROMINE	Kr 83.80 KRYPTON		
5	Rb 85.468 RUBIDIUM	Sr 87.62 STRONTIUM	Y 88.906 YTRIUM	Zr 91.224 ZIRCONIUM	Nb 92.906 NIOBIUM	Mo 95.94 MOLYBDENUM	Tc 98 TECHNETIUM	Ru 101.07 RUTHENIUM	Rh 102.91 RHODIUM	Pd 106.42 PALLADIUM	Ag 107.87 SILVER	Cd 112.41 CADMIUM	In 114.82 INDIUM	Sn 118.71 TIN	Sb 121.76 ANTIMONY	Te 127.60 TELLURIUM	I 126.90 IODINE	Xe 131.29 XENON		
6	Cs 132.91 CAESIUM	Ba 137.33 BARIUM	La-Lu 57-71 Lanthanide	Hf 178.49 HAFNIUM	Ta 180.95 TANTALUM	W 183.84 TUNGSTEN	Re 186.21 RHENIUM	Os 190.23 OSMIUM	Ir 192.22 IRIDIUM	Pt 195.08 PLATINUM	Au 196.97 GOLD	Hg 200.59 MERCURY	Tl 204.38 THALLIUM	Pb 207.2 LEAD	Bi 208.98 BISMUTH	Po (209) POLONIUM	At (210) ASTATINE	Rn (222) RADON		
7	Fr (223) FRANCIUM	Ra (226) RADIUM	Ac-Lr 89-103 Actinide	Rf (261) RUTHERFORDIUM	Db (262) DUBNIUM	Sg (266) SEABORGIUM	Bh (264) BOHRNIUM	Hs (277) HASSIUM	Mt (288) MEITNERIUM	Uun (281) UNUNUNIUM	Uuu (272) UNUNNIUM	Uub (285) UNUNBIUM	Uuq (289) UNUNQUADIUM							
LANTHANIDE																				
6	La 138.91 LANTHANUM	Ce 140.12 CERIUM	Pr 140.91 PRASEODYMIUM	Nd 144.24 NEODYMIUM	Pm (145) PROMETHIUM	Sm 150.36 SAMARIUM	Eu 151.96 EUROPIUM	Gd 157.25 GADOLINIUM	Tb 158.93 TERBIUM	Dy 162.50 DYSPROSIUM	Ho 164.93 HOLMIUM	Er 167.26 ERBIUM	Tm 168.93 THULIUM	Yb 173.04 Ytterbium	Lu 174.97 LUTETIUM					
ACTINIDE																				
7	Ac 227 ACTINIUM	Th 232.04 THORIUM	Pa 231.04 Protactinium	U 238.03 URANIUM	Np 237 NEPTUNIUM	Pu 244 PLUTONIUM	Am 243 AMERICIUM	Cm 247 CURIUM	Bk 247 BERKELIUM	Cf 251 CALIFORNIUM	Es 252 EINSTEINIUM	Fm 257 FERMIUM	Md 258 MENDELEVIUM	No 259 NOBELIUM	Lr 262 LAWRENCIUM					

- Aluminium and iron are an element of the periodic table.
- When scrap is melted to be recycled, it will be identical to primary Aluminium or Iron.
- No quality loss, it recycles forever.



Chemical structure: the name is bond



- Bonding forces of the molecules is key for permanent materials.
- The bonding forces between the atoms in the molecule has to be stronger than the forces between the molecules.
- This strong bonding force safeguards the inherent characteristics of the material and enables multiple recycling through melting or even vaporizing.

Material stewardship

The second pillar of the Concept of Permanent Materials is **how** they are used:

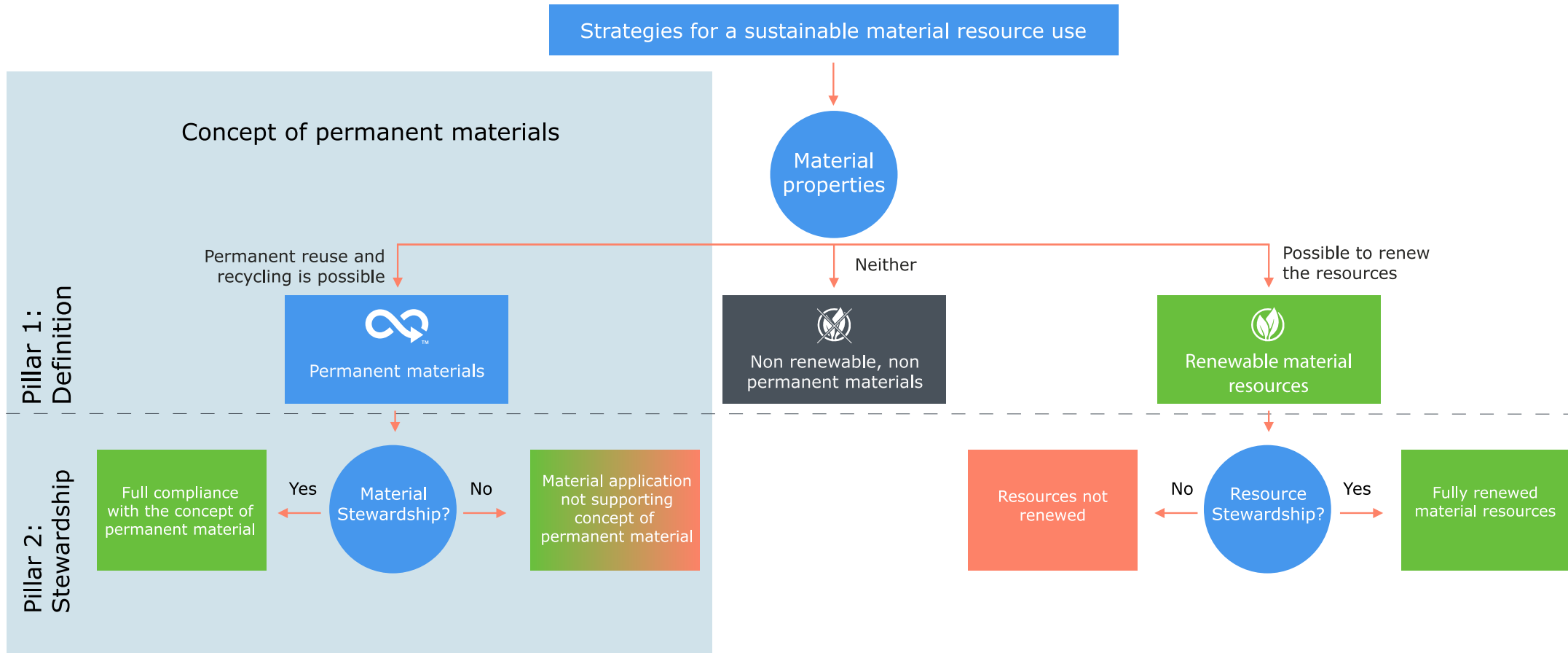


The material must contribute to sustainable development.



It should be technically available for recycling.
(for example materials used in medical pills are no longer available and can thus not be recycled)

Material Classification according to sustainable development strategies



Metal, a true recycling story

- 80% of all metal ever produced is still in use today. Today's can could become part of tomorrow's train or building.
- Where efficient recovery systems are in place, recycling rates exceed 90%.
- Recycling one tonne of metal scrap uses 70-95% less energy than making one tonne of metal from virgin raw material.
- Metals close the material loop without being confined to a single application.

