

I materiali costituenti i RAEE e il loro recupero

Modulo 1 - Scienza e Ingegneria



This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

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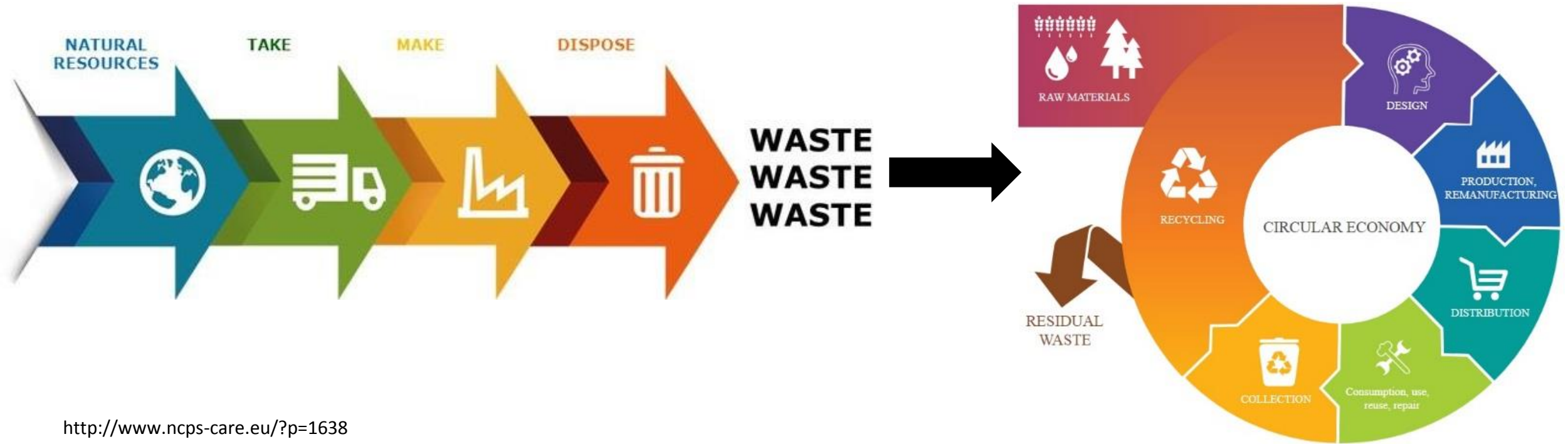
Giulia Ischia

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Dal modello «Take-Make-Dispose» alla «Circular Economy»



<http://www.ncps-care.eu/?p=1638>

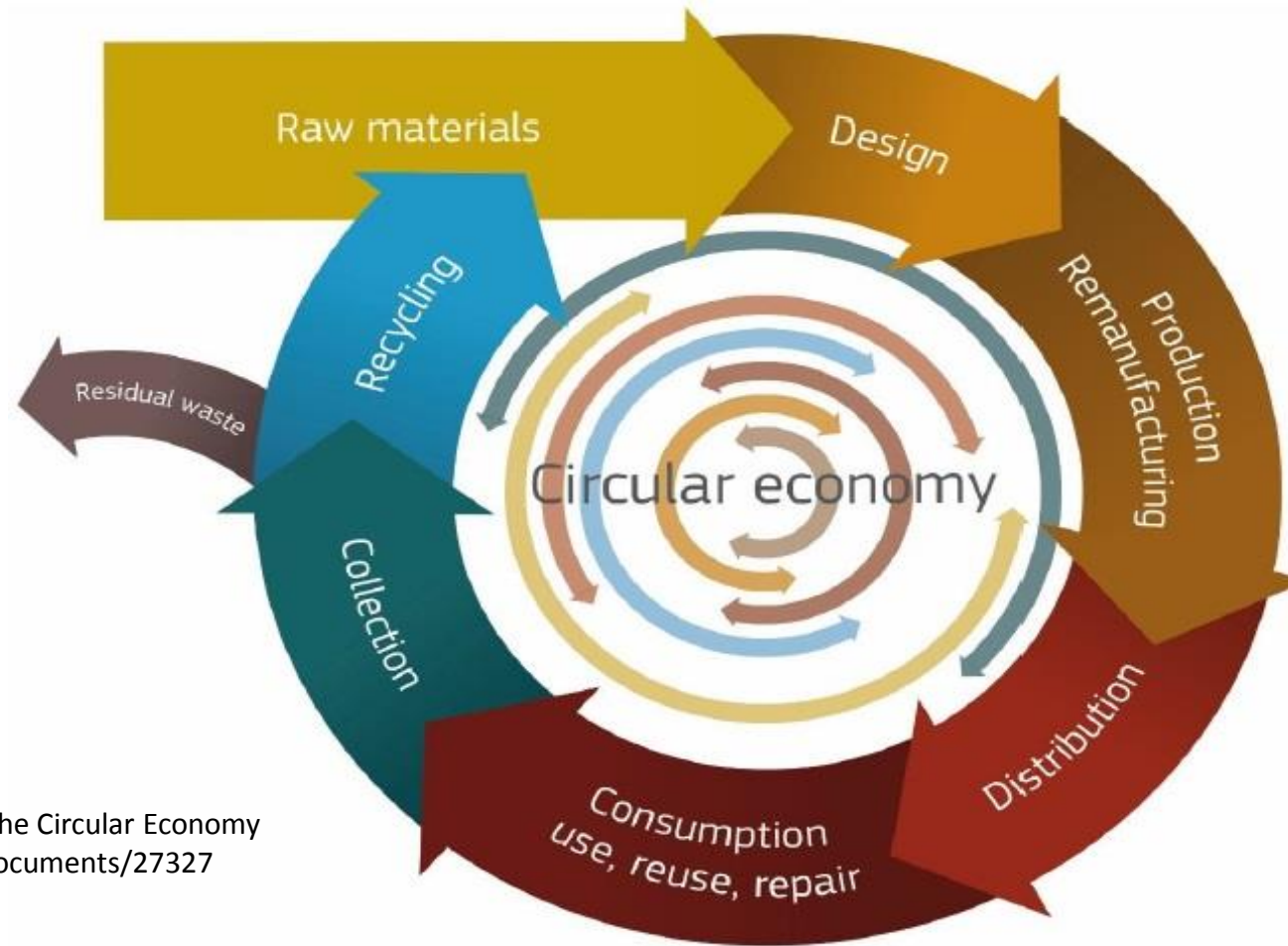
<https://www.dccae.gov.ie/en-ie/environment/topics/sustainable-development/circular-economy/Pages/default.aspx>



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Circular Economy: Diagramma Concettuale

La materia prima è reimpressa nel sistema produttivo



Report on Critical Raw Materials and the Circular Economy
<https://ec.europa.eu/docsroom/documents/27327>



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Le 5 R dei rifiuti: riduzione, riuso, riciclo, raccolta, recupero



- 1 RIDUZIONE** Riduzione all'origine del rifiuto: politica e scelte del singolo cittadino
- 2 RIUSO** Riparo-Reinventare e ricollocare prodotti e beni ancora riutilizzabili
- 3 RICICLO** Immettere nuovamente una risorsa seconda nel ciclo di produzione, nel ruolo di risorsa prima
- 4 RACCOLTA** Raccolta differenziata, attraverso la separazione dei rifiuti prodotti, per categorie di materiali e di imballaggi.
- 5 RECUPERO** Valorizzazione energetica (recupero di energia elettrica e termica)

<https://www.econote.it/2014/08/28/le-5-r-dei-rifiuti/>



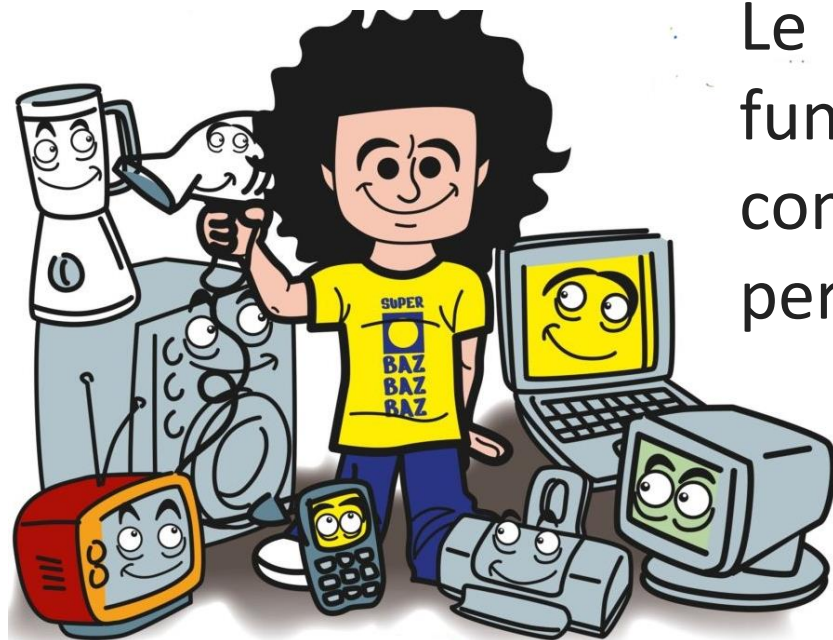
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AEE: (apparecchiature elettriche ed elettroniche)



Le **AEE** sono apparecchiature che per un corretto funzionamento dipendono dall'energia elettrica, sia come utilizzatrici, sia come generatrici, progettate per funzionare a tensioni non superiori a 1000 V



RAEE: (rifiuti da app. elettriche ed elettroniche)



RAEE sono i rifiuti di apparecchiature elettriche ed elettroniche, ovvero tutti quegli AEE di cui il proprietario vuole disfarsi per obsolescenza, guasto, inutilizzo etc.

Gli utilizzatori finali, le aziende produttrici, i centri di raccolta e recupero RAEE sono i principali attori del corretto smaltimento di tali rifiuti.

principio normativa europea “**chi inquina paga**”.

Entro il 2019 come target di raccolta a cui devono tendere i Paesi europei il 65% del peso medio delle AEE immesse sul mercato nei tre anni precedenti.

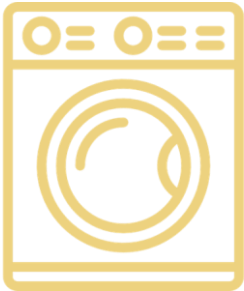
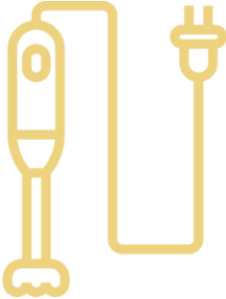
<https://www.lentepubblica.it/wp-content/uploads/2015/02/RAEE.jpg>

https://www.cd craee.it/GetHome.pub_do

CENTRO DI COORDINAMENTO
RAEE

Categorie RAEE

I RAEE si differenziano tra loro per l'insieme di materie prime di cui sono composti e per l'impiego che avevano prima di diventare rifiuto.

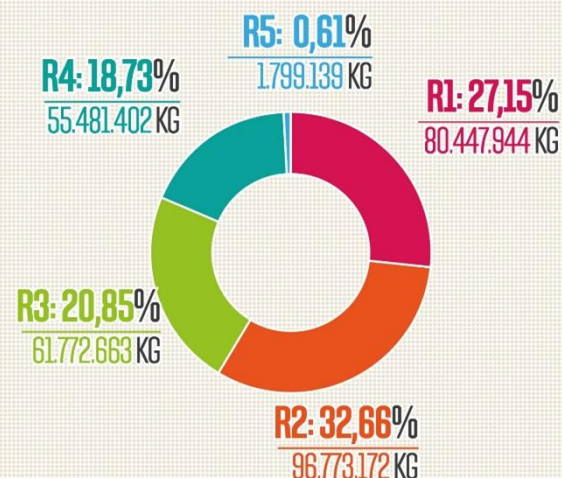
R1 freddo e clima  (pericolosi)	R2 grandi bianchi  (non pericolosi)	R3 televisori e monitor  (pericolosi)	R4 piccoli elettrodomestici  (pericolosi e non)	R5 sorgenti luminose  (pericolosi)
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RACCOLTA COMPLESSIVA
296.274.320 KG

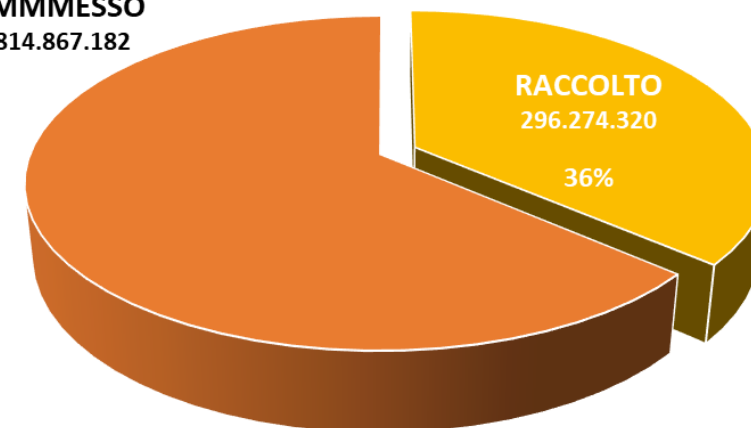
+4,66 % INCREMENTO
RACCOLTA VS 2016

RACCOLTA PRO CAPITE
NAZIONALE **4,89 KG**

LA RACCOLTA NEI 5 RAGGRUPPAMENTI



IMMESSO
814.867.182



RACCOLTA % 2017 RISPETTO
ALL'IMMESSO NEL 2016

RACCOLTA 2017 [kg]

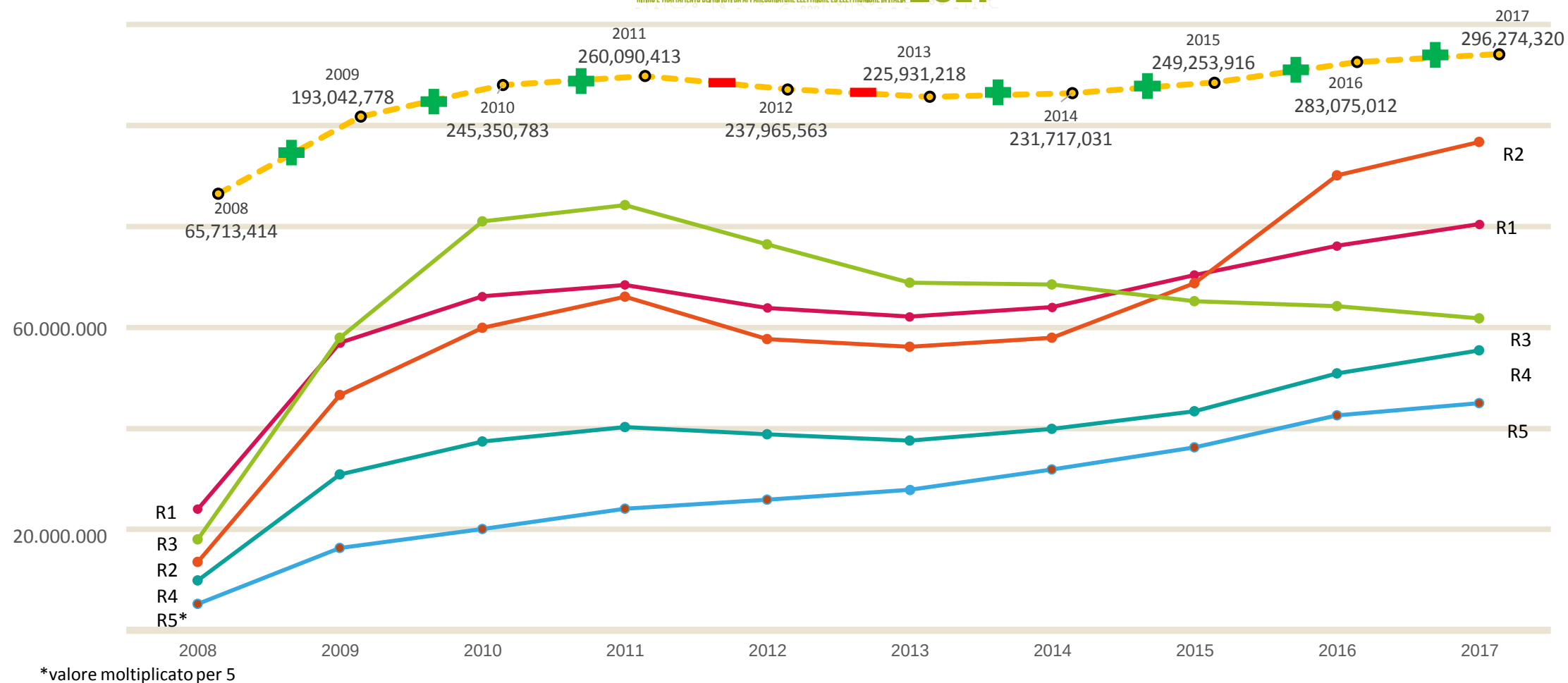
https://www.cd craee.it/GetPage.pub_do?id=2ca980954c369c25014ce55c67350385



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Andamento della raccolta negli ultimi 10 anni [kg]

RAPPORTO ANNUALE 2017
RITIRO E TRATTAMENTO DEI RIFIUTI DA APPARECCHIATURE ELETTRICHE ED ELETTRONICHE IN ITALIA



https://www.cdcrare.it/GetPage.pub_do?id=2ca980954c369c25014ce55c67350385

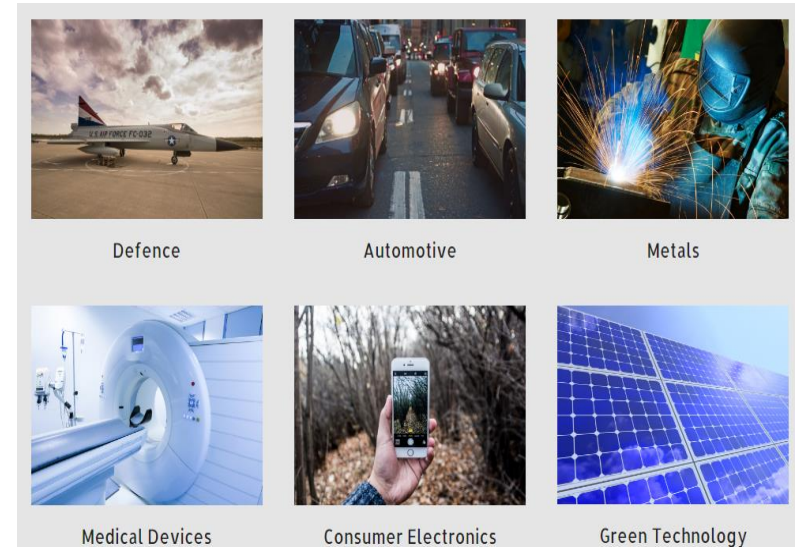


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Perché è importante il recupero dei RAEE

- I materiali costituenti i RAEE non sono biodegradabili
- Rischio inquinamento ambientale
- Risorse naturali esauribili
- Critical raw materials



<http://www.sudpress.it/rifiuti-crocetta-potremo-requisire-bellolampo-orlando-emergenza-frutto-di-un-governo-inadeguato/>



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Cosa è una discarica?

Perché i RAEE non vanno abbandonati?

Fase di realizzazione



Fase operativa



Fase di chiusura



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Fase di realizzazione

<http://www.pisatoday.it/cronaca/visita-enrico-rossi-discardica-peccioli-25-luglio-2019.html>



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Fase operativa



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Fase di chiusura

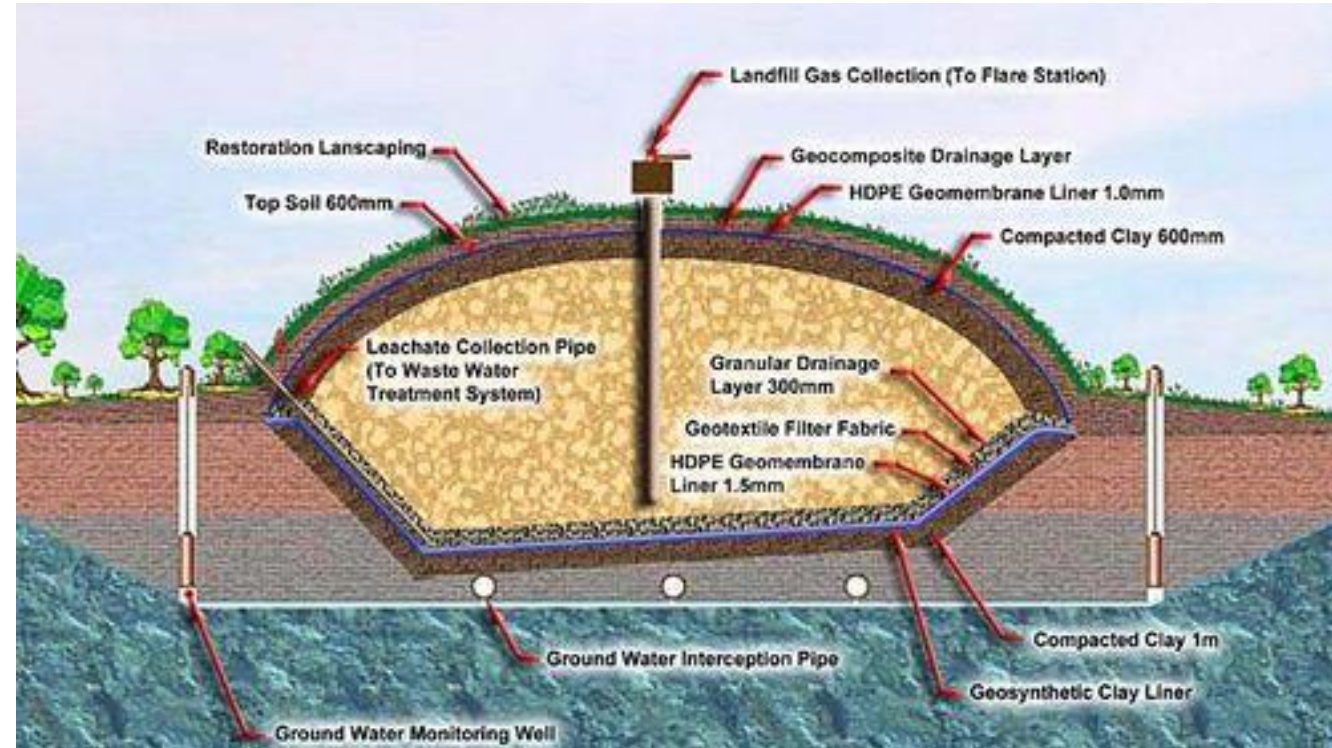
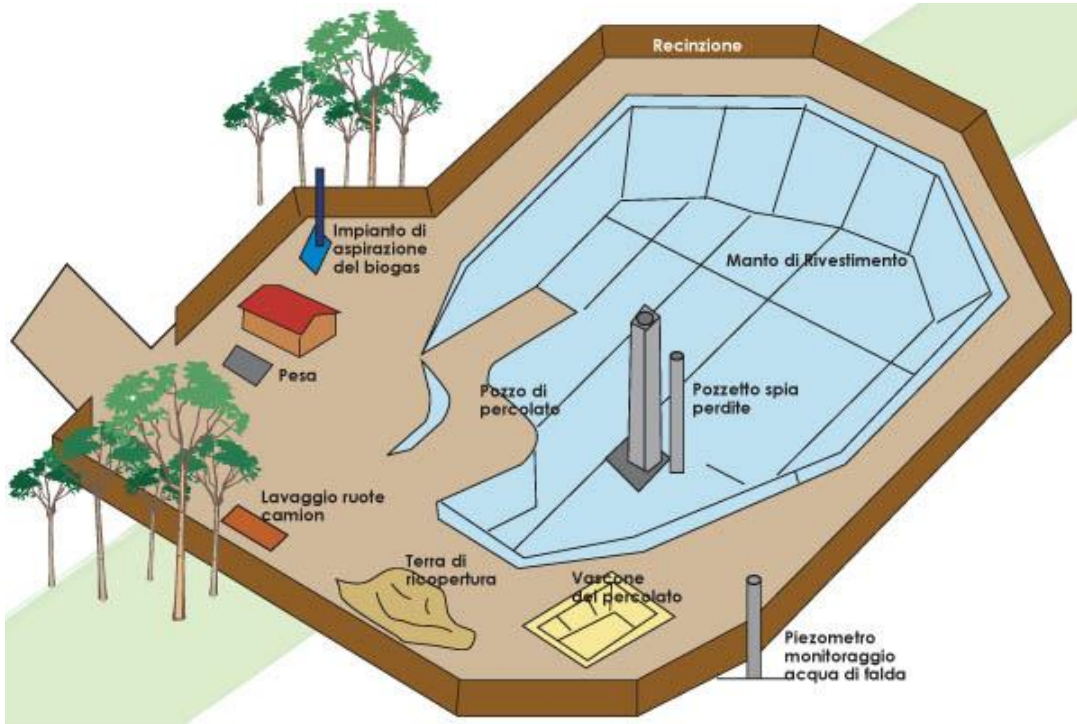


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Come funziona una discarica, quali i pericoli!



http://www.crati.it/por_calabria/Sito/Pannello10/Discariche.html

<http://www.geotecnologie.unisi.it/corsinew.php?act=det&wat=0&id=1901>



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I RAEE ed il loro recupero

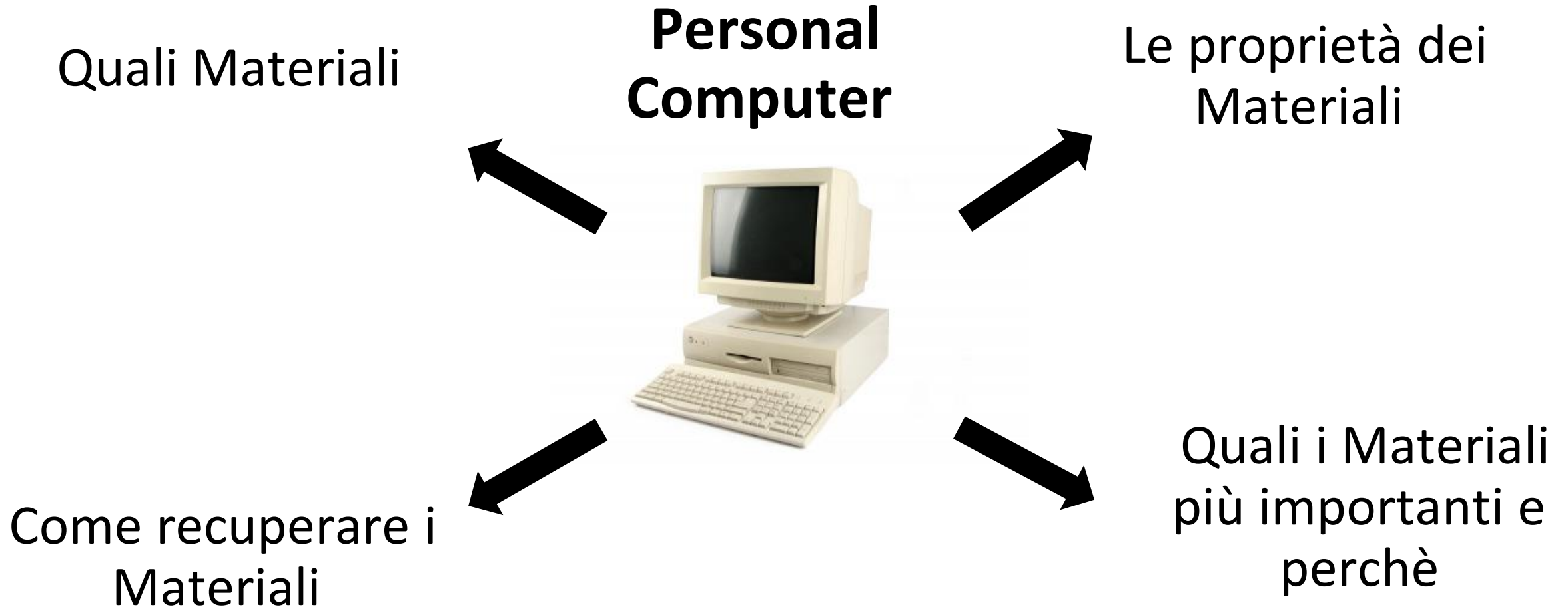
<https://www.youtube.com/watch?v=hB2DzYB4Tt0>



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Di cosa è fatto il mio vecchio PC?



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Di cosa è fatto il mio vecchio PC? i materiali e le loro proprietà

Personal Computer



Materiale	Contenuto %	Materiale	Contenuto %	Materiale	Contenuto %
Materie plastiche	22,9	Tantalio	16×10^{-3}	Argento	19×10^{-3}
Piombo	6,4	Indio	2×10^{-3}	Antimonio	9×10^{-3}
Alluminio	14,2	Vanadio	2×10^{-4}	Cromo	$6,3 \times 10^{-3}$
Germanio	2×10^{-3}	Berillio	$15,7 \times 10^{-3}$	Cadmio	$9,4 \times 10^{-3}$
Gallio	1×10^{-3}	Oro	$1,6 \times 10^{-3}$	Selenio	$1,6 \times 10^{-3}$
Ferro	20,5	Europio	2×10^{-3}	Radio	1×10^{-3}
Stagno	1	Titanio	$15,7 \times 10^{-3}$	Platino	$0,1 \times 10^{-3}$
Rame	6,9	Rutenio	$1,6 \times 10^{-3}$	Mercurio	$2,2 \times 10^{-3}$
Bario	$3,2 \times 10^{-2}$	Cobalto	$15,7 \times 10^{-3}$	Silicio (vetro)	24,9
Nichel	0,9	Palladio	3×10^{-4}		
Zinco	2,2	Manganese	$31,5 \times 10^{-3}$		



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Materiali presenti nei RAEE



Materiali
Plastici
(polimeri)



VETRI

RAEE



METALLI



CRMs



Composti
CHIMICI



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[illegible]

6	58	140,12	59	140,9077	60	144,24	61	(145)	62	150,4	63	151,96	64	157,25	65	158,9254	66	162,5	67	164,9304	68	167,26	69	168,9342	70	173,04	71	174,96
	+4	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	
	6,9 79,32 34,26	Ce	6,48 330,9 35,12	Pr	6,96 101,3 36,68	Nd	7,22 108,0 24,60	Pm	7,75 107,19 17,91	Sm	5,24 8,05 15,67	Eu	7,9 131,19 32,66	Gd	8,23 130,69 32,23	Tb	8,55 140,7 29,62	Dy	8,7 140,9 26,95	Ho	9,87 149,7 28,63	Er	9,32 154,19 19,47	Tm	6,97 82,9 11,94	Yb	9,84 168,9 33,95	Lu
	Cerio	Praseodimio	Neodimio	Promezio	Samario	Europio	Gadolinio	Terbio	Disprosio	Olmio	Erbio	Tulio	Itterbio	Lutezio														
7	90	232,0381	91	(209)	92	238,029	93	237,046	94	(244)	95	(243)	96	(247)	97	(247)	98	(251)	99	(252)	100	(257)	101	(258)	102	(259)	103	(261)
	+4	+4	+6 5,4,3	+6 5,4,3	+6 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	+8 5,4,3	
	11,3 184,2 47,68	Th	1590	Pa	18,7 112,9 41,34	U	30,25 636,5 39,92	Np	18,94 945 32,30	Pu	12,67 1175 26,14	Am	13,81 1340 26,14	Cm	13,81 1340 26,14	Bk	13,81 1340 26,14	Cf	13,81 1340 26,14	Es	13,81 1340 26,14	Fm	13,81 1340 26,14	Md	13,81 1340 26,14	No	13,81 1340 26,14	Lr
	Torio	Protoattinio	Uranio	Nettunio	Plutonio	Americio	Curio	Berchelio	Californio	Einsteinio	Fermio	Mendelevio	Nobelio	Laurenzio														



Serie degli Attinidi



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I Metalli

- **Definizione di materiale metallico, quali le sue proprietà?**
- **Cosa si intende per metallo comune e metallo nobile?**
- **Cosa si intende per passivazione di un metallo o di una lega?**
- **In quale forma si trovano comunemente in natura? Quali le fonti?**



Materiali metallici

Materiale metallico

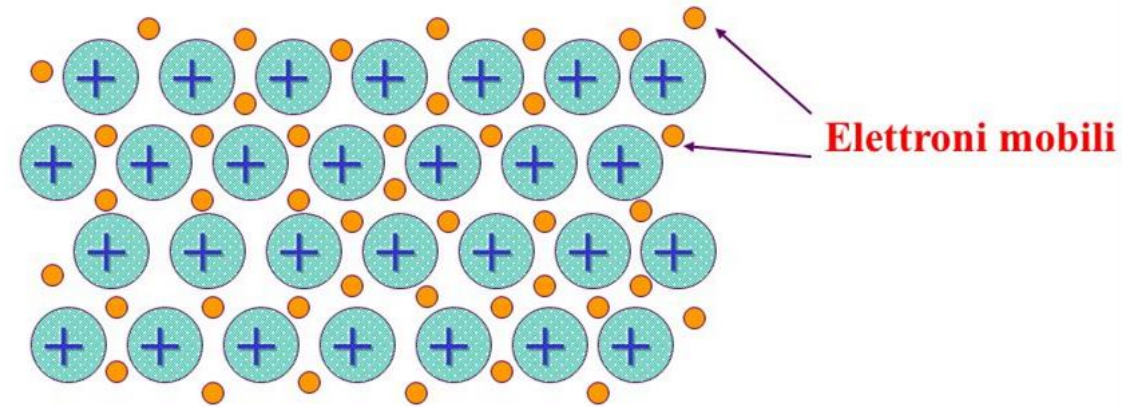
1. Resistenza meccanica

1. Conducibilità elettrica e termica

1. Duttilità

Modello semplificato del legame metallico:

Reticolo di cationi immersi in un “mare” di elettroni mobili



I legami sono delocalizzati nell'intero cristallo e gli elettroni di valenza non sono legati ad un particolare atomo ma possono muoversi liberamente da un atomo all'altro



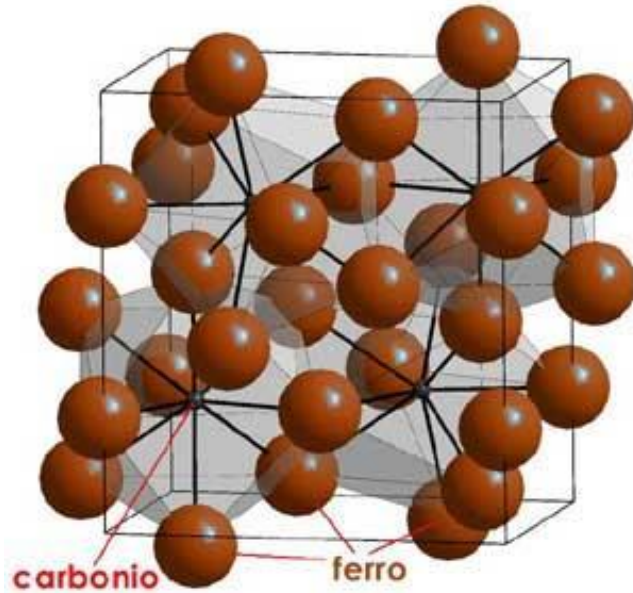
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Materiali metallici e leghe

Una lega è una combinazione, in soluzione o in miscela, di due o di più elementi, di cui almeno uno è un metallo e dove il materiale risultante ha proprietà metalliche differenti da quelle dei relativi componenti.



Acciaio: Lega Fe-C

Acciaio dolce: C < 2%

Ghisa: C > 2%

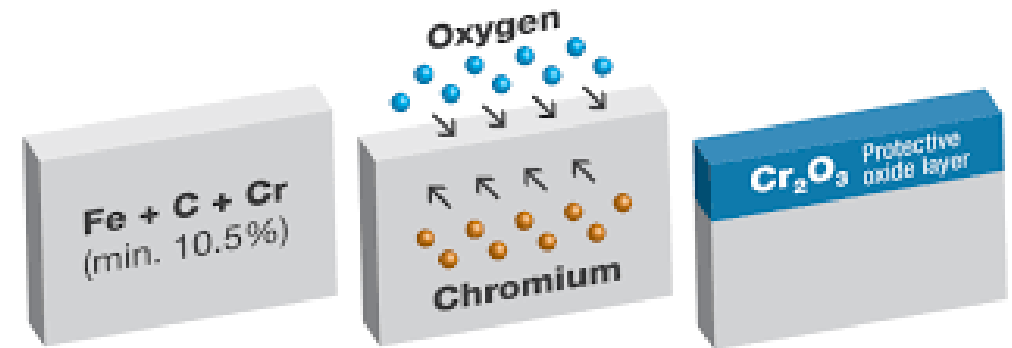
http://www.brunoacciai.it/tecniche_materiali/acciaio_caratteristiche.php

Acciaio: INOX

AISI (*American Iron and Steel Institute*),

AISI 304 - Cr (18%) Ni (10%) C (0,05%);

AISI 316 - Cr (16%) Ni (11.3/13 %) Mo (2/3 %)



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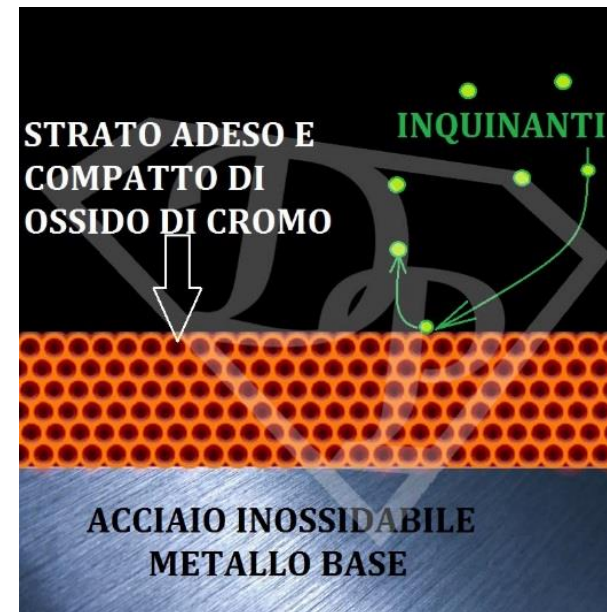
Corrosione e passivazione dei metalli

Corrosione: ossidazione non controllata con la formazione di uno strato di ossido poroso e non adesivo.

Passivazione: ossidazione controllata del metallo con la formazione di un sottile strato di ossido metallico adesivo e non poroso



Metallo non passivato



Metallo passivato



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Corrosione dei metalli



Cosa succede al mio telefono quando cade in acqua?



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Classificazione dei Metalli: Metalli Comuni

Ferro (Fe)



pf 1538 °C,
 $E_{\text{redox}} = -0.41 \text{ V}$
 40 €/t

Alluminio (Al)



pf 660 °C,
 $E_{\text{redox}} = -1.66 \text{ V}$
 1.7 €/kg

Tavola Periodica degli Elementi

1 H Hydrogen																	2 He Helium
3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium											13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
55 Cs Cesium	56 Ba Barium	57 La Lanthanum	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89 Ac Actinium	104 Rf Rutherfordium	105 Ha Hassium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	(113)	(114)	(115)	(116)	(117)	(118)

Lanthanide series

Actinide series

58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium
90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium



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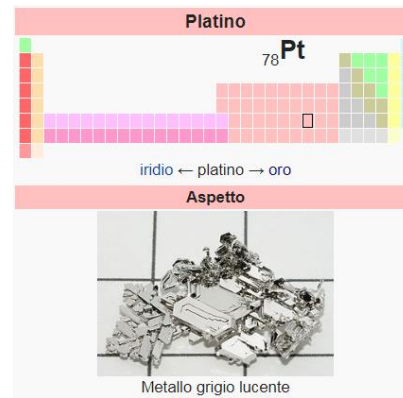


Oro (Au)



pf 1069 °C,
 $E_{\text{redox}} = 1.69 \text{ V}$
 34.8 €/g

Platino (Pt)



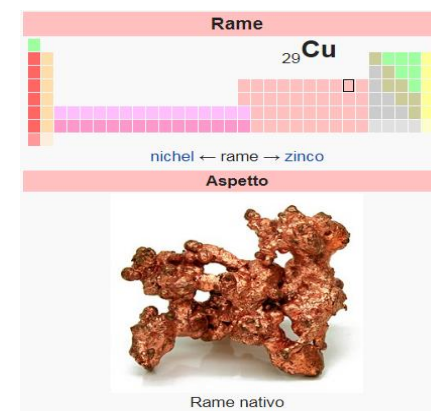
pf 1768 °C,
 $E_{\text{redox}} = 1.19 \text{ V}$
 24.8 €/g

Argento (Ag)



pf 981 °C,
 $E_{\text{redox}} = 0.80 \text{ V}$
 0.4 €/g

Rame (Cu)



pf 1084 °C,
 $E_{\text{redox}} = 0.34 \text{ V}$
 5.4 €/kg

Tavola Periodica degli Elementi

Periodic Table of Elements																		1			
1 H 1.008																		2 He 4.003			
3 Li 6.941	4 Be 9.012															5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305															13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.065	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.88	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.63	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.8				
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc 98	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.6	53 I 126.9	54 Xe 131.3				
55 Cs 132.91	56 Ba 137.33	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 144.91	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97					
87 Fr [223]	88 Ra [226]	89 Ac [227]	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu 244.06	95 Am 243.06	96 Cm 247.07	97 Bk 247.07	98 Cf 251.08	99 Es 252.08	100 Fm 257.10	101 Md 258.10	102 No 259.10	103 Lr 262.10					
Lanthanide series																		1			
Actinide series																		1			

Metalli Nobili

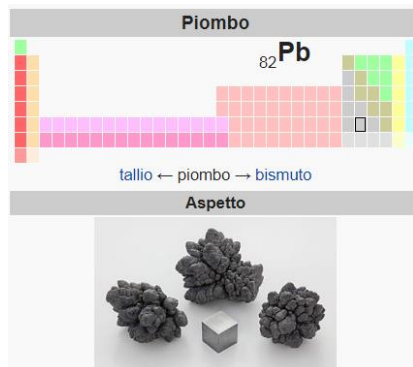


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Piombo (Pb)



pf 327 °C,

Mercurio (Hg)



pf – 38 °C,



Altri Metalli

Tavola Periodica degli Elementi

1 1.01 H Hydrogen																	2 4.00 He Helium						
3 6.94 Li Lithium	4 9.01 Be Beryllium																	5 10.81 B Boron	6 12.01 C Carbon	7 14.01 N Nitrogen	8 15.99 O Oxygen	9 18.98 F Fluorine	10 20.18 Ne Neon
11 22.99 Na Sodium	12 24.31 Mg Magnesium																	13 26.98 Al Aluminum	14 28.09 Si Silicon	15 30.97 P Phosphorus	16 32.06 S Sulfur	17 35.45 Cl Chlorine	18 39.90 Ar Argon
19 39.10 K Potassium	20 40.08 Ca Calcium	21 44.96 Sc Scandium	22 47.88 Ti Titanium	23 50.94 V Vanadium	24 51.99 Cr Chromium	25 54.94 Mn Manganese	26 55.85 Fe Iron	27 58.93 Co Cobalt	28 58.93 Ni Nickel	29 63.55 Cu Copper	30 65.37 Zn Zinc	31 69.72 Ga Gallium	32 72.64 Ge Germanium	33 74.92 As Arsenic	34 78.96 Se Selenium	35 79.90 Br Bromine	36 83.80 Kr Krypton						
37 85.47 Rb Rubidium	38 87.62 Sr Strontium	39 88.91 Y Yttrium	40 91.22 Zr Zirconium	41 92.91 Nb Niobium	42 95.94 Mo Molybdenum	43 98.91 Tc Technetium	44 101.07 Ru Ruthenium	45 101.07 Rh Rhodium	46 106.42 Pd Palladium	47 107.87 Ag Silver	48 112.41 Cd Cadmium	49 114.82 In Indium	50 118.71 Sn Tin	51 127.40 Sb Antimony	52 127.60 Te Tellurium	53 126.91 I Iodine	54 131.29 Xe Xenon						
55 132.91 Cs Cesium	56 137.33 Ba Barium	57 138.91 La Lanthanum	58 175.07 Hf Hafnium	59 178.49 Ta Tantalum	60 180.95 W Tungsten	61 186.21 Re Rhenium	62 186.21 Os Osmium	63 190.23 Ir Iridium	64 195.08 Pt Platinum	65 196.97 Au Gold	66 200.59 Hg Mercury	67 204.38 Tl Thallium	68 207.19 Pb Lead	69 208.98 Bi Bismuth	70 208.98 Po Polonium	71 209 At Astatine	72 210 Rn Radon						
87 223 Fr Francium	88 226 Ra Radium	89 227 Ac Actinium	90 261 Rf Rutherfordium	91 262 Ha Hahnium	92 266 Sg Seaborgium	93 262 Bh Bohrium	94 266 Hs Hassium	95 266 Mt Meitnerium	110 271 Ds Darmstadtium	111 272 111 Roentgenium	112 277 112 Copernicium	113 277 113 Nihonium	114 285 114 Flerovium	115 285 115 Moscovium	116 289 116 Livermorium	117 289 117 Tennessine	118 294 118 Oganesson						

Lanthanide series

58 140.12 Ce Cerium	59 140.91 Pr Praseodymium	60 144.24 Nd Neodymium	61 144.91 Pm Promethium	62 150.40 Sm Samarium	63 151.96 Eu Europium	64 157.25 Gd Gadolinium	65 158.93 Tb Terbium	66 162.50 Dy Dysprosium	67 164.93 Ho Holmium	68 167.26 Er Erbium	69 168.93 Tm Thulium	70 173.04 Yb Ytterbium	71 174.07 Lu Lutetium
-------------------------------------	---	--	---	---------------------------------------	---------------------------------------	---	--------------------------------------	---	--------------------------------------	-------------------------------------	--------------------------------------	--	---------------------------------------

Actinide series

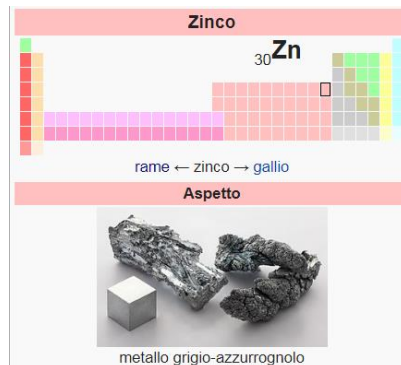
90 232.04 Th Thorium	91 231.04 Pa Protactinium	92 238.03 U Uranium	93 237.05 Np Neptunium	94 244.06 Pu Plutonium	95 244.06 Am Americium	96 247.07 Cm Curium	97 247.07 Bk Berkelium	98 251.08 Cf Californium	99 252.08 Es Einsteinium	100 257.10 Fm Fermium	101 262.10 Md Mendelevium	102 268.10 No Nobelium	103 269.10 Lr Lawrencium
--------------------------------------	---	-------------------------------------	--	--	--	-------------------------------------	--	--	--	---------------------------------------	---	--	--

Cadmio (Cd)



pf 594 °C,

Zinco (Zn)



pf 693 °C,
E_{redox} = -0.77 V

Litio (Li)

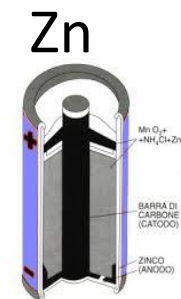


pf 454 °C,

Li



Pb

Ni/
Cd

Metalli: le fonti minerali



Magnetite (Fe_3O_4)

<https://www.minieredicalamita.it/capoliveri-miniere/cuore-terra.html>



Bauxite (ricco in $\text{Al}(\text{OH})_3$)



Calcopirite (CuFeS_2)



<https://itimoni.it/america/viaggio-in-cile-e-isola-di-pasqua/>



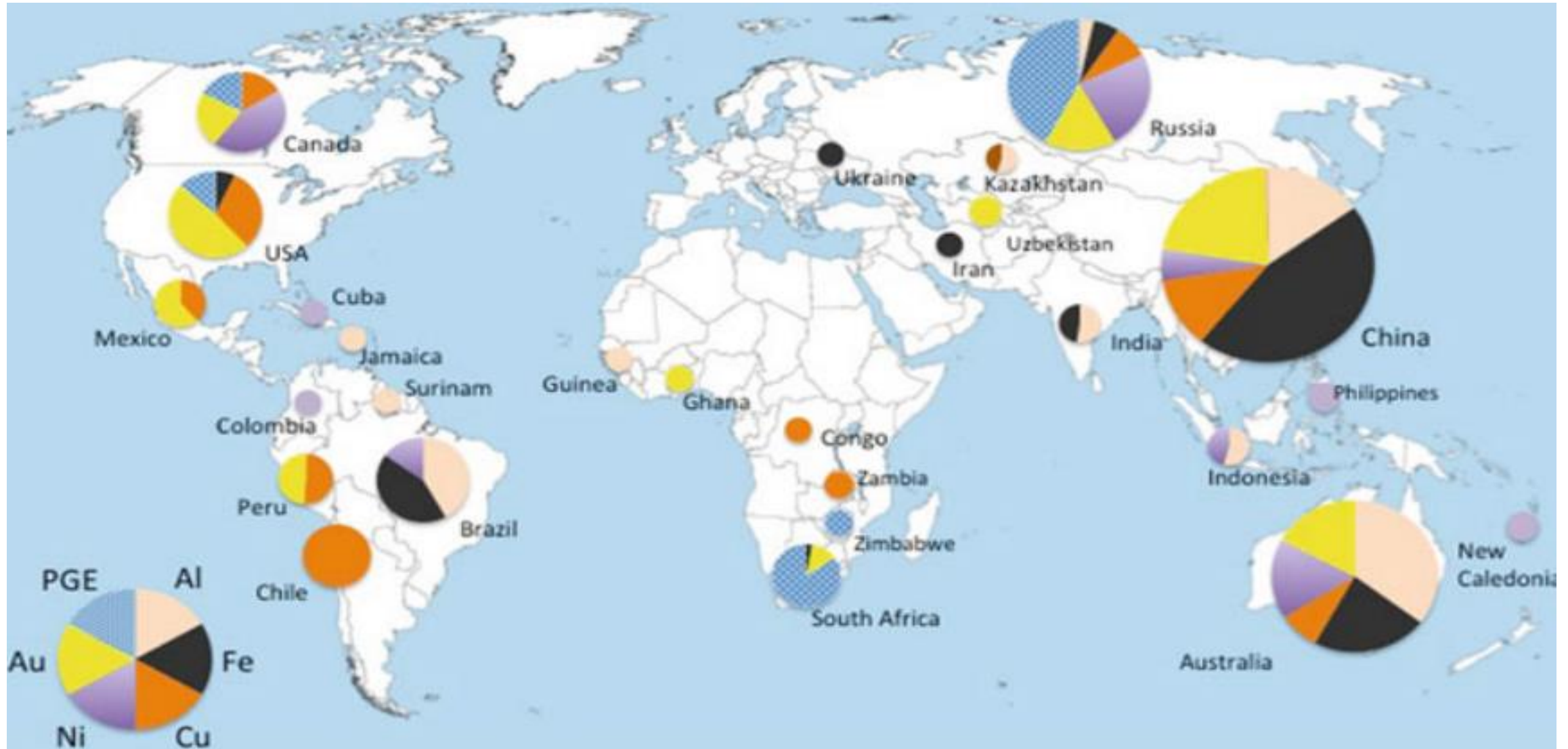
This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

Supported by:



RawMaterials
Connecting matters

Distribuzione globale dei metalli



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Metalli: fonti del RAME

Calcopirite



Bornite

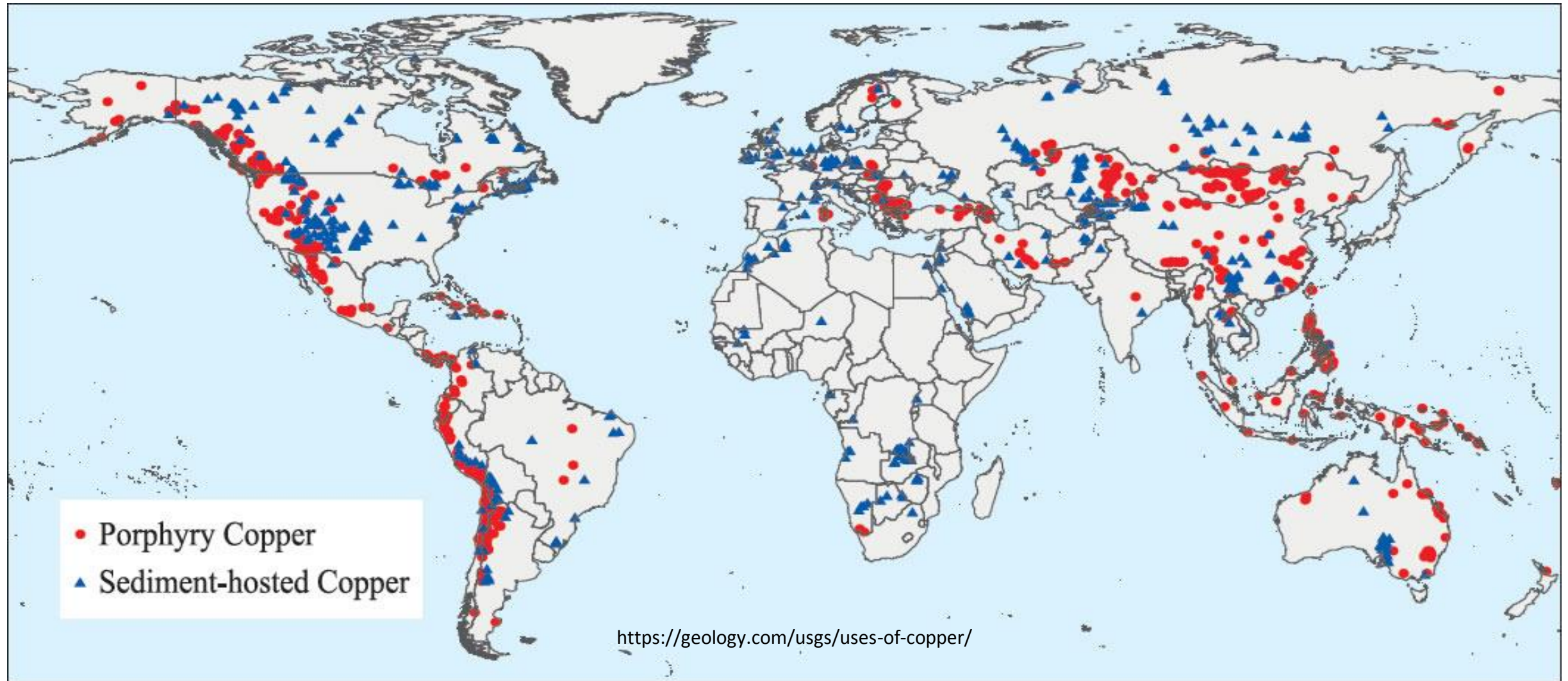


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RAME distribuzione nel globo



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Le Miniere di RAME

<https://www.youtube.com/watch?v=Z-kfODjpB7M>

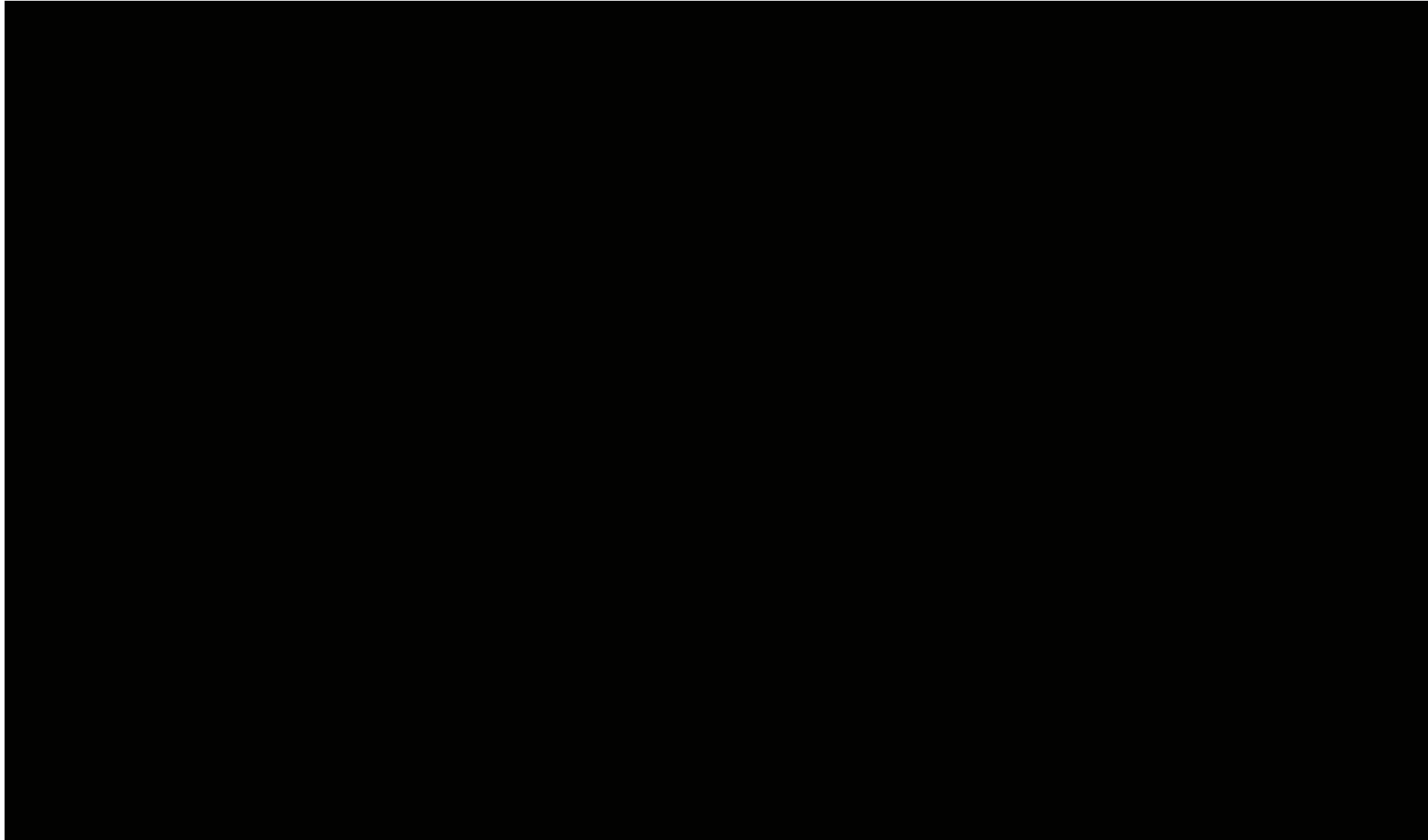


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Le Miniere di RAME

<https://www.youtube.com/watch?v=Z-kfODjpB7M>



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Dalla Miniera Tradizionale alla Miniera Urbana

Miniera di Rame



- Estrazione del rame
- Frantumazione e macinazione
- Flottazione
- Concentrazione
- Arrostimento
- Fusione e conversione
- Raffinazione termica
- Raffinazione elettrolitica

**To Mine or not
To Mine?**



URBAN MINING



- Raccolta RAEE
- Recupero del rame dal RAEE
- Fusione
- Raffinazione termica
- Raffinazione elettrolitica



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I materiali Polimerici

RAEE



<https://www.eco-mind.it/portfolio-articoli/rifiuti-raee/>



Macinazione delle Plastiche

<https://www.ecoambientesud.it/raee.html>



Materiali Polimerici (Plastiche)



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I Polimeri

- **Cos'è un materiale polimerico?**
- **Polimeri naturali e polimeri sintetici, fonti ed esempi**
- **Cosa si intende per Termoplastico, Termoindurente, Gomma?**
- **Polimero amorfo e cristallino?**
- **Definizione dei Materiali compositi**
- **Recupero e valorizzazione dei materiali polimerici**



I Polimeri - definizioni

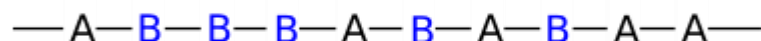
Un **polimero** è una sostanza macromolecolare ovvero una molecola dall'elevato peso molecolare, costituita dalla ripetizione di un gran numero di unità ripetitive uguali o diverse (co-polimero), legate tra loro da legami covalenti.



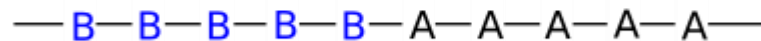
1 **Polimero lineare omo-polimero (stessa unità ripetitiva)**



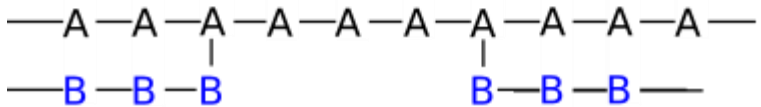
2 **Polimero lineare co-polimero (almeno due unità ripetitive)**



3 **Polimero lineare co-polimero (random)**



4 **Polimero lineare co-polimero (a blocchi)**



5 **Polimero lineare co-polimero (a innesto)**

<https://it.wikipedia.org/wiki/Polimero>



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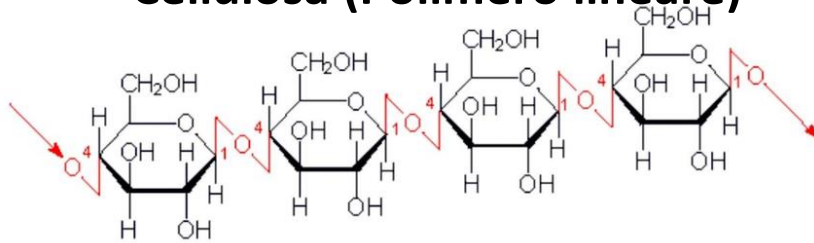
Supported by:



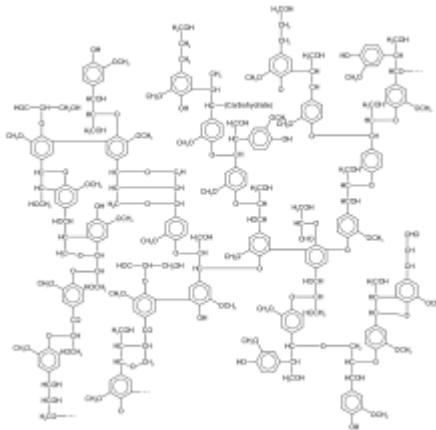
Polimeri naturali e polimeri sintetici

Polimeri naturali

Cellulosa (Polimero lineare)

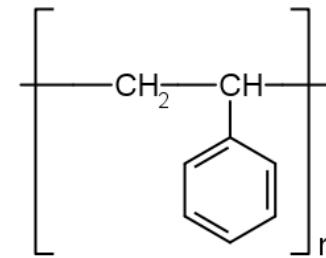


Lignina (Polimero reticolato)

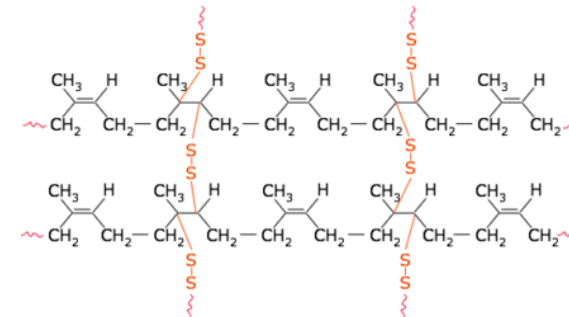


Polimeri sintetici

polistirene (Polimero lineare)



Polibutadiene (Polimero reticolato)



I Polimeri: le fonti

I polimeri termoplastici come il polietilene e polipropilene vengono sintetizzati per addizione a partire dai rispettivi monomeri: etilene e propilene che sono essenzialmente di derivazione minerale e petrolifera:

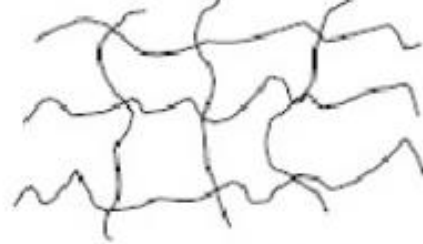


This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

I Polimeri Amorfi e Cristallini



Polimero lineare



Polimero reticolato



Polimero ramificato



Struttura amorfa (random)



Struttura semi-cristallina



Struttura con legami incrociati -
termoindurente
(es. gomma vulcanizzata)



Polietilene ad alta densità HDPE



Polietilene a bassa densità LDPE



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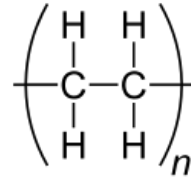
Supported by:



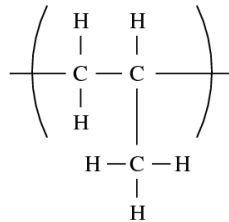
I Polimeri Termoplastici

I polimeri termoplastici sono fusibili e pertanto possono essere fusi e rimodellati

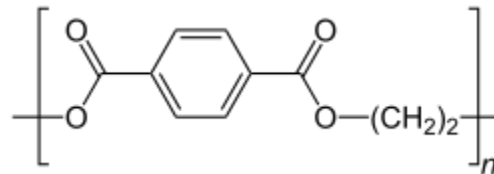
PE polietilene



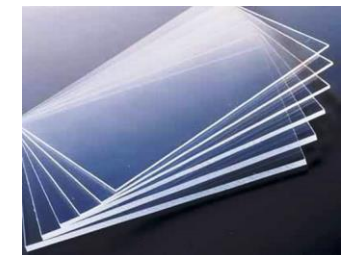
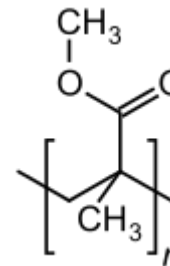
PP polipropilene



PET polietilentereftalato



PMMA polimetilmetacrilato (plexiglass)



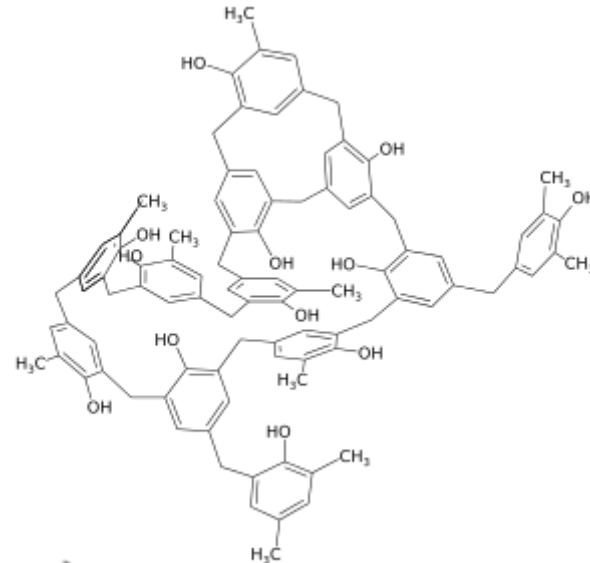
This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

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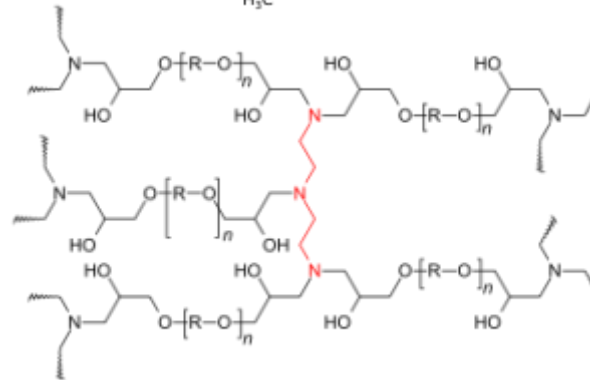
I Polimeri Termoindurenti

I polimeri termoindurenti sono composti reticolati non fusibili, hanno elevate proprietà meccaniche, termiche e chimiche ma si decompongono alle alte temperature.

Bachelite (resina fenolica)



Resina Epossidica



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I materiali compositi

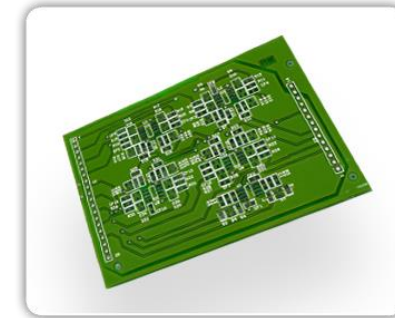
I materiali compositi sono costituiti da più materiali che uniti conferiscono all'oggetto elevate caratteristiche meccaniche e chimiche, un esempio è la vetroresina (tessuto in fibra di vetro e resina ftalica) materiale composita in fibra di carbonio fibre di carbonio e resina epossidica



Tessuto in fibra di vetro



Resina Ftalica



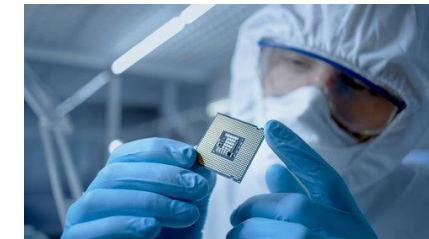
Piastra PCB



Tessuto in fibra di carbonio



Resina Ftalica



Componenti avanzate
per l'elettronica



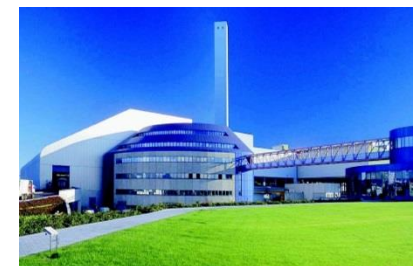
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I Polimeri: raccolta, riciclo e valorizzazione

**Raccolta RAEE e
separazione plastiche**



**Manufatto in
plastica riciclata**



**Termo-
valorizzazione**



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RAEE - vetri e composti chimici (Critical Raw Materials)

RAEE- Monitor



Tubo Catodico

<https://www.qsl.net/ik1hgi/472khz/impedenza.htm>



VETRI



Terre Rare

Fosforo

<https://www.regionieambiente.it/ritiro-e-trattamento-dei-raee/>

Le terre rare il fosforo ed altri materiali o i materiali utilizzati nei tubi catodici, i display a cristalli liquidi, e per questi sono impiegati l'eurolio ed il fosforo rosso, ma anche altri composti chimici delle terre rare. Questi elementi sono tra quelli indicati come critical raw materials

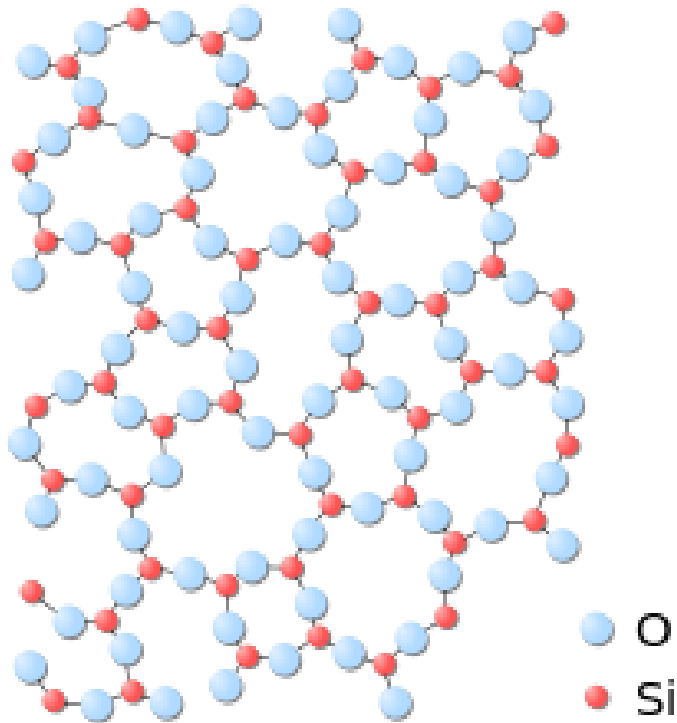


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Il Vetro

Il vetro è un liquido sottoraffreddato che si presenta come un solido amorfo ovvero una sostanza in cui gli atomi non si sono arrangiati in un reticolo cristallino.



Vetro speciale PYREX



Il boro è aggiunto sotto forma di borace ($\text{Na}_2\text{B}_4\text{O}_7$) o acido borico (H_3BO_3) per migliorare le caratteristiche termiche ed elettriche (PYREX).



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Il Vetro - riciclo

Il vetro può essere riciclato un numero di volte illimitato senza alcuna alterazione, nel processo di riciclo per ottenere vetri di elevata qualità i differenti tipi di vetro però devono essere separati onde evitare la presenza di sostanze additive non desiderate



<https://www.ecofocus.it/2016/01/da-vetro-rinasce-vetro/>

<http://www.elysglass.com/glassIdeas.asp>



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European Commission Publishes New Critical Raw Materials List

27 CRMs Confirmed



On 13 September 2017, the European Commission published a Communication on its long-awaited 2017 list of Critical Raw Materials (CRMs), which features 27 raw materials and updates the 2014 list. The primary purpose of the list is to identify the raw materials with a high supply-risk and a high economic importance to which reliable and unhindered access is a concern for European industry and value chains. Following an objective methodology the list provides a factual tool for trade, innovation and industrial policy measures to strengthen the competitiveness of European industry in line with the renewed industrial strategy for Europe, for instance by:

- **identifying investment needs which can help alleviate Europe's reliance on imports of raw materials;**
- **guiding support to innovation on raw materials supply under the EU's Horizon 2020 research and innovation programme;**
- **drawing attention to the importance of critical raw materials for the transition to a low-carbon, resource-efficient and more circular economy**

It is hoped that the list will help incentivize the European production of critical raw materials through enhancing recycling activities and when necessary to facilitate the launching of new mining activities.

The new list features 27 raw materials: Antimony, Beryllium, Borates, Cobalt, *Coking Coal, Fluorspar, Gallium, Germanium, Indium, Magnesium, Natural Graphite, Niobium, Phosphate Rock, Silicon Metal, Tungsten, Platinum Group Metals, Light Rare Earths and Heavy Rare Earths, Baryte, Bismuth, Hafnium, Helium, Natural Rubber, Phosphorus, Scandium, Tantalum, and Vanadium.

*it is important to note that Coking Coal is considered a borderline case. Although it narrowly misses the economic importance threshold, for the sake of caution, coking coal is kept on the list of critical raw materials for the EU and thus included in the table. However, it will be phased out from the next list should it fail to meet the criteria in full.

<https://ec.europa.eu/transparency/regdoc/rep/1/2017/EN/COM-2017-490-F1-EN-MAIN-PART-1.PDF>



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Materie Prime Critiche «CRM» nei RAEE

<https://youtu.be/03E1-GIhLQs>



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Materie Prime Critiche «CRMs»

La commissione Europea identifica con uno specifico documento i materiali critici, materiali che presentano una elevata importanza strategica per il loro utilizzo in settori ad alta tecnologia, materiali che non sono sostituibili e che presentano problematiche di approvvigionamento sia per la loro ridotta quantità sia per problemi geopolitici che ne limitano la possibilità di reperimento



Defence



Automotive



Metals



Medical Devices



Consumer Electronics



Green Technology

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	**	104 Rf	105 Db	106 Sg	107 Sg	108 Hs	109 Mt	110 Ds	111 Rg	112 Uub	113 Uut	114 Uug	115 Uup	116 Uuh	117 Uus	118 Uuo

 > 50 %
 > 25-50 %
 > 10-25 %
 1-10 %
 < 1 %

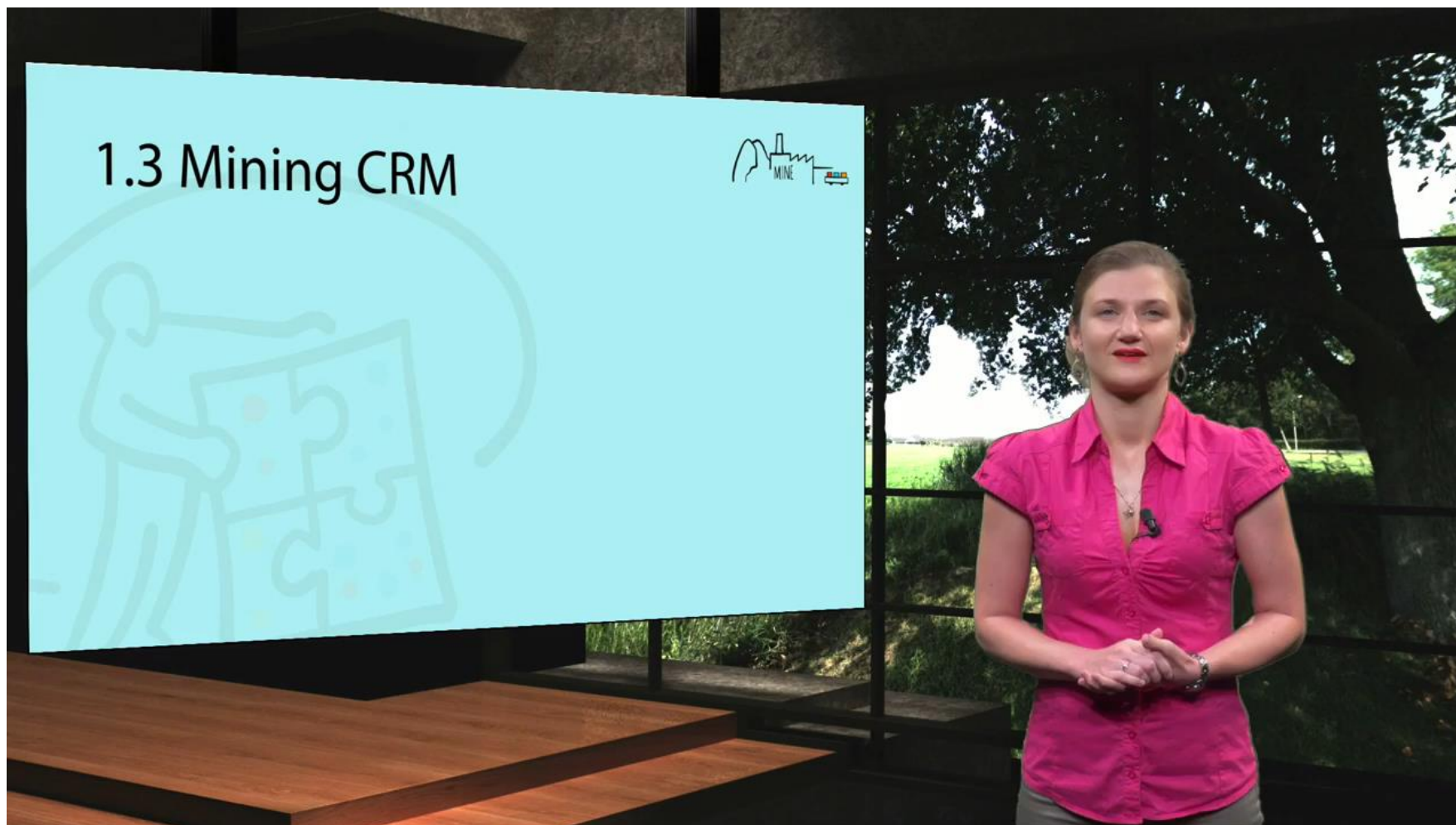
* Lanthanides

**** Actinides**

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Materie Prime Critiche Problematiche legate all'approvvigionamento

<https://youtu.be/tnknjWyJ5S4>



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Critical Raw Materials- I Fattori Chiave

E' importante far notare che queste materie prime NON sono classificate come critiche esclusivamente per le scares reserve ma piuttosto perchè:

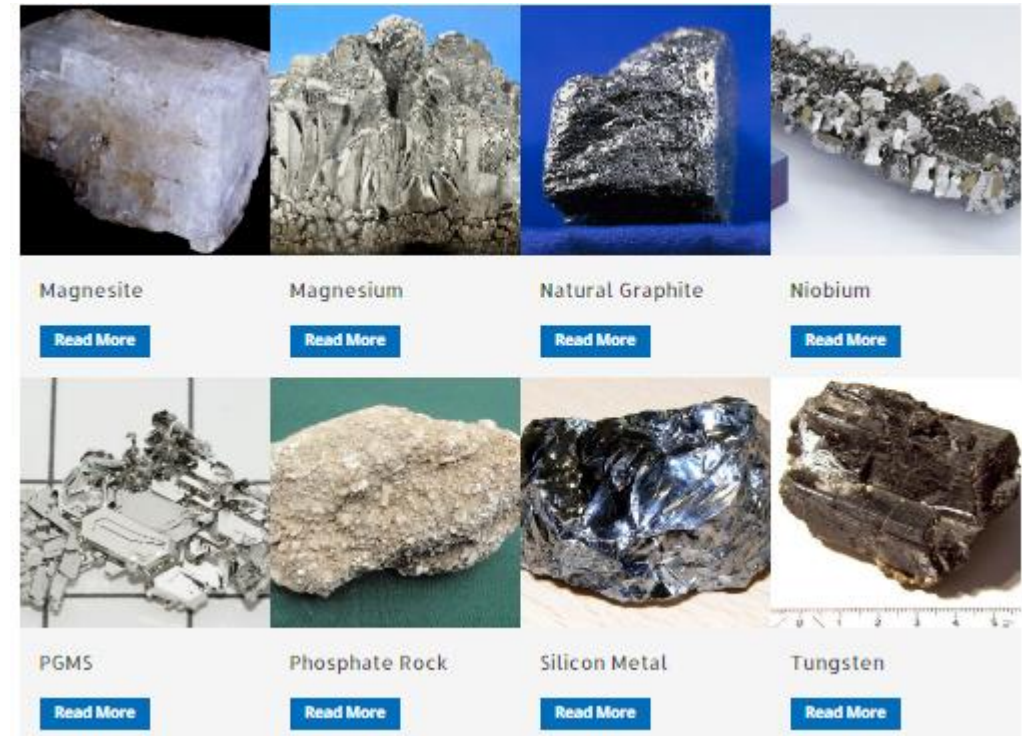
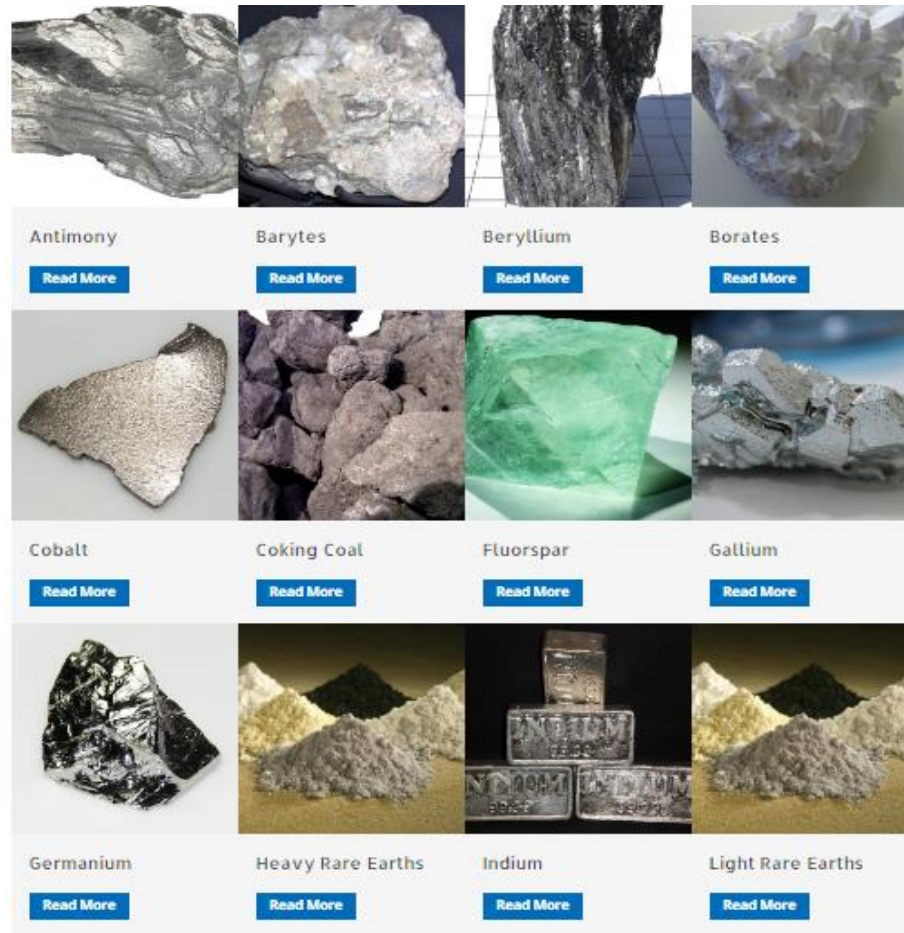
1. **Elevata importanza economica per fattori chiave dell'economia Europea**, come elettronica di consumo, tecnologie ambientali, settore automotive, aerospazio, difesa, salute e produzione dell'acciaio
2. **Elevato rischio di approvvigionamento** a causa dell'elevate dipendenza ed alte concentrazioni di categorie di questi materiali in specifici paesi
3. **Mancanza di (possibili) sostituti**, a causa della unicità delle proprietà di questi materiali per le applicazioni esistenti e future.



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27 Critical Raw Materials

La Commissione Europea nell'ultimo aggiornamento della lista dei Critical Raw Materials include 27 materiali tra cui quelli elencati di sotto:



<http://criticalrawmaterials.org/>



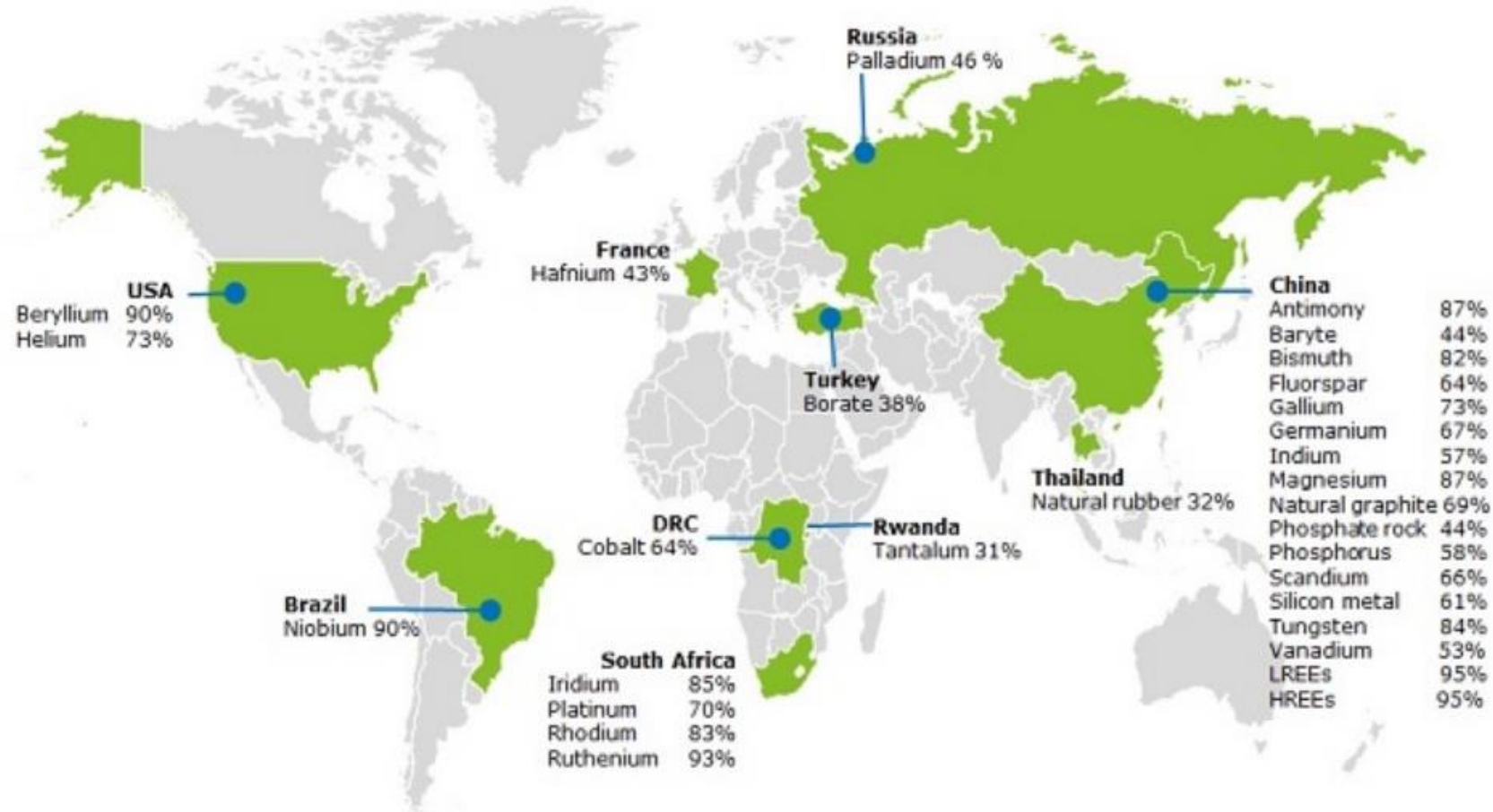
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Global Share of Critical Raw Materials

Countries accounting for largest share of global supply of CRMs



<http://criticalrawmaterials.org/>



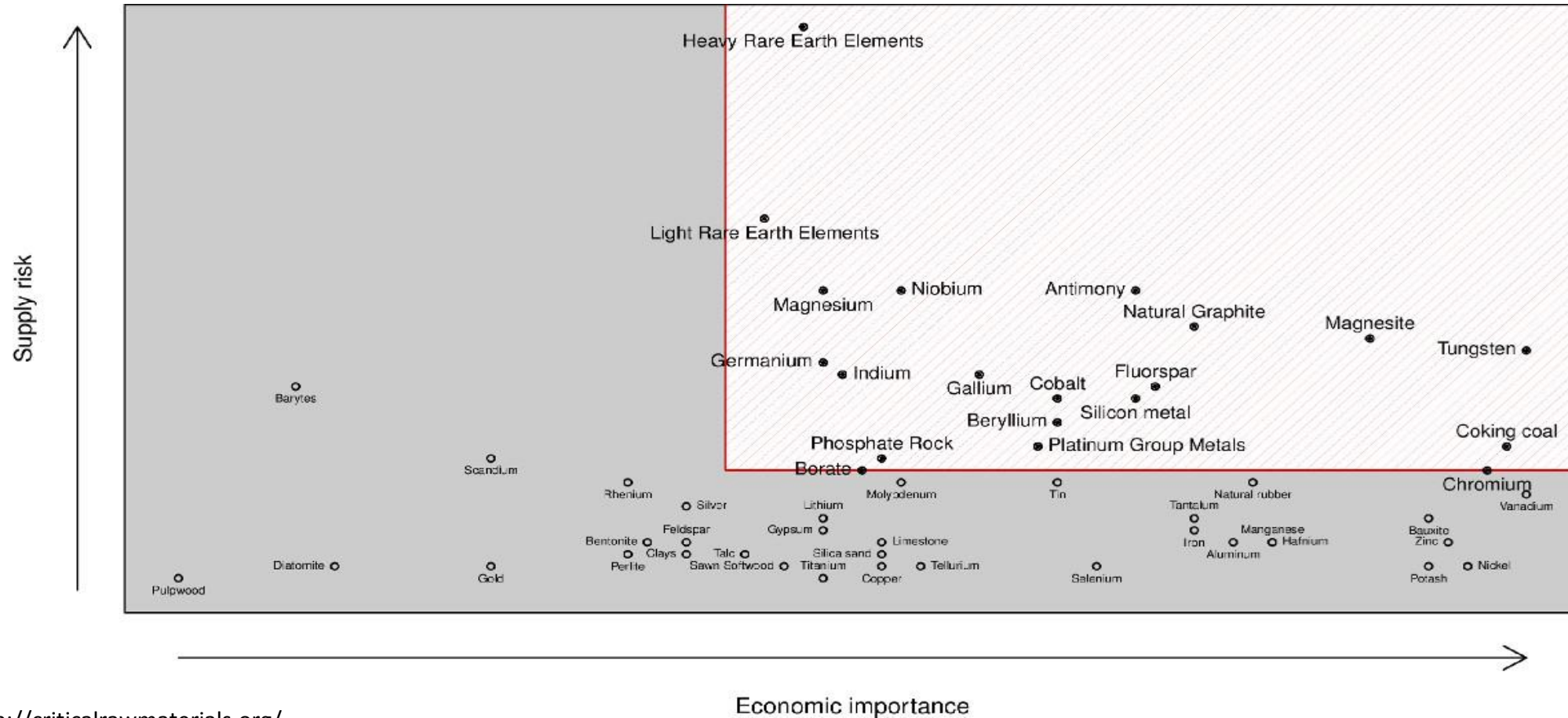
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Critical Raw Materials

Magnesio, Antimonio, Fosforo, Terre Rare (leggere e pesanti etc. sono tra le materie prime maggiormente considerate critiche



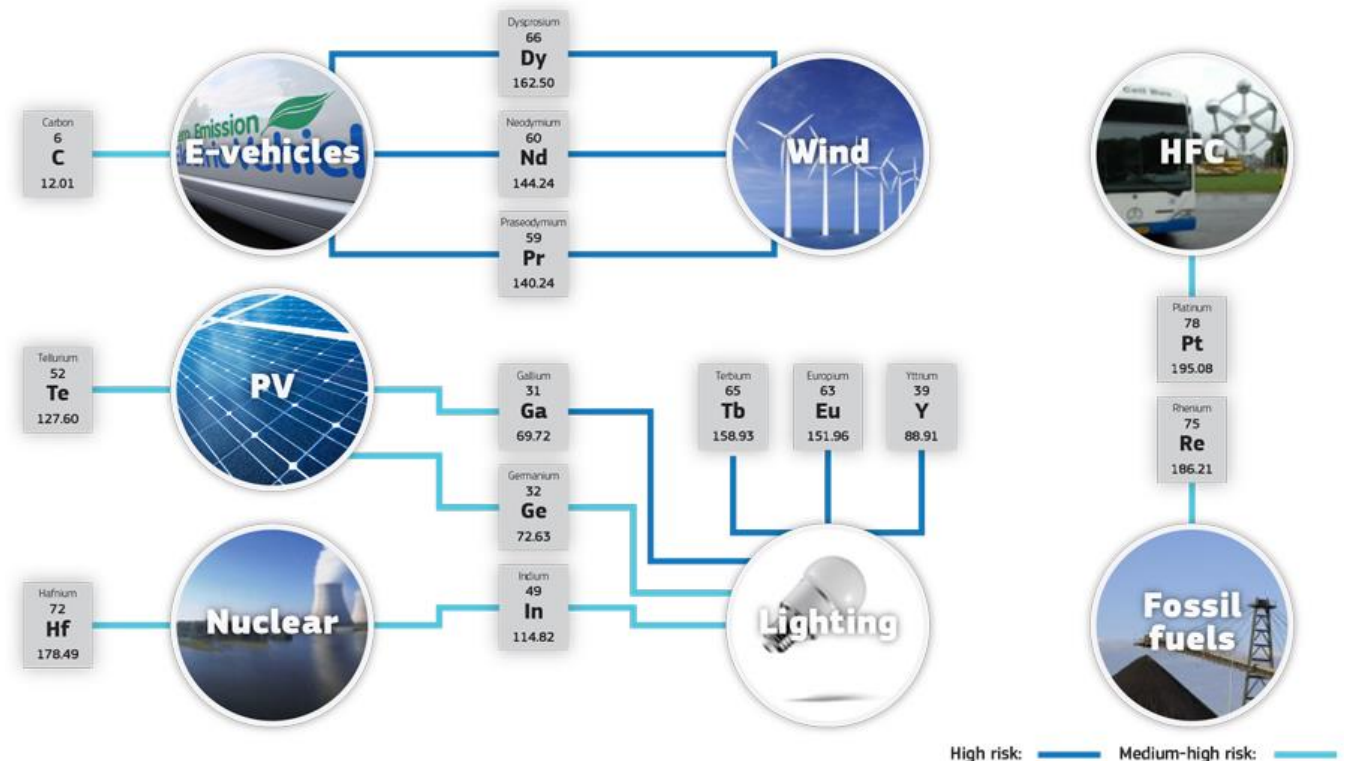
<http://criticalrawmaterials.org/>



This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

Critical Raw Materials – Risk Rating and Technology Applications

Raw Material	Risk Rating	Associated Technology
Rare Earths: Dy, Pr, Nd	High	e-vehicles, wind
Rare Earths: Eu, Tb, Y	High	lighting
Gallium	High	lighting, solar
Tellurium	High	solar
Graphite	Medium-High	e-vehicles
Rhenium	Medium-High	fossil fuels
Hafnium	Medium-High	nuclear
Germanium	Medium-High	lighting
Platinum	Medium-High	fuel cells
Indium	Medium-High	solar, lighting, nuclear



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➤ **Il recupero e riciclo dei CRMs è di importanza strategica per L'Europa**



<https://www.habitante.it/habitare/living-e-tendenze/imparare-il-risparmio-energetico-e-ledilizia-sostenibile-un-nuovo-lavoro/>



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