

Processi per il recupero delle materie prime dai RAEE - tecnologie in uso e processi innovativi

Modulo 2 – Scienza e Ingegneria



Impianti di Recupero e Trattamento RAEE



<https://www.youtube.com/watch?v=GCozwMZ3QaY>



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Il recupero dei materiali dai RAEE

Separazione Manuale delle componenti

Vagliatura Manuale dei materiali e recupero di materiali speciali (polveri, gas etc.)

**Trattamenti meccanici di macinazione
(mulino a martelli)**

**Recupero meccanico
dei materiali macinati**

Metalli

Metalli Ferromagnetici (Fe, Co, Ni etc.)

Metalli non Ferromagnetici (Al, Cu etc.)

Materiali non metallici

Vetri

Materiali polimerici



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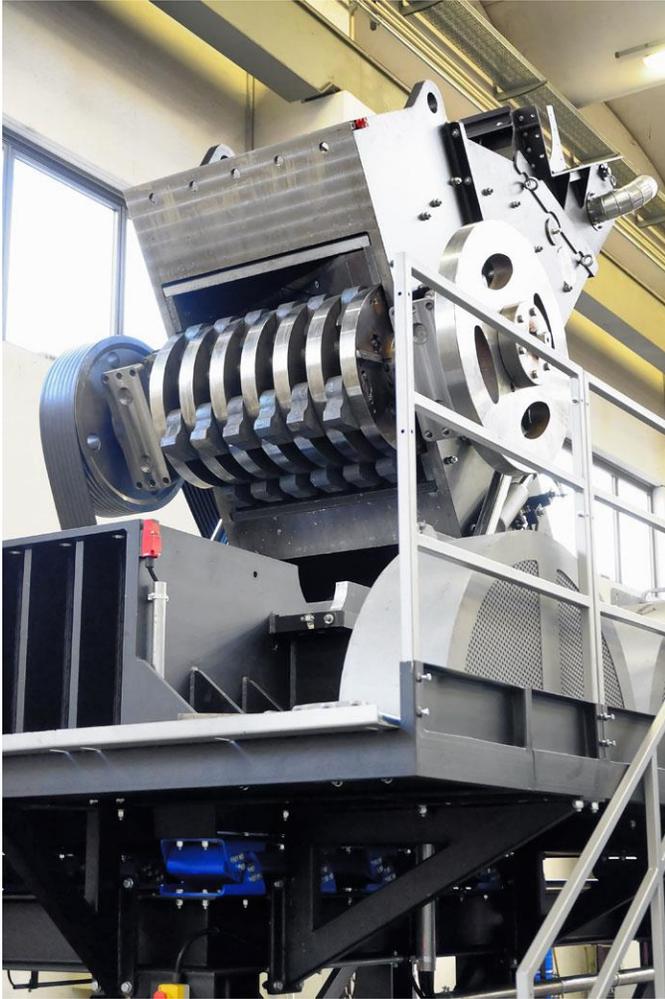
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Macinazione meccanica: Mulini a Martelli



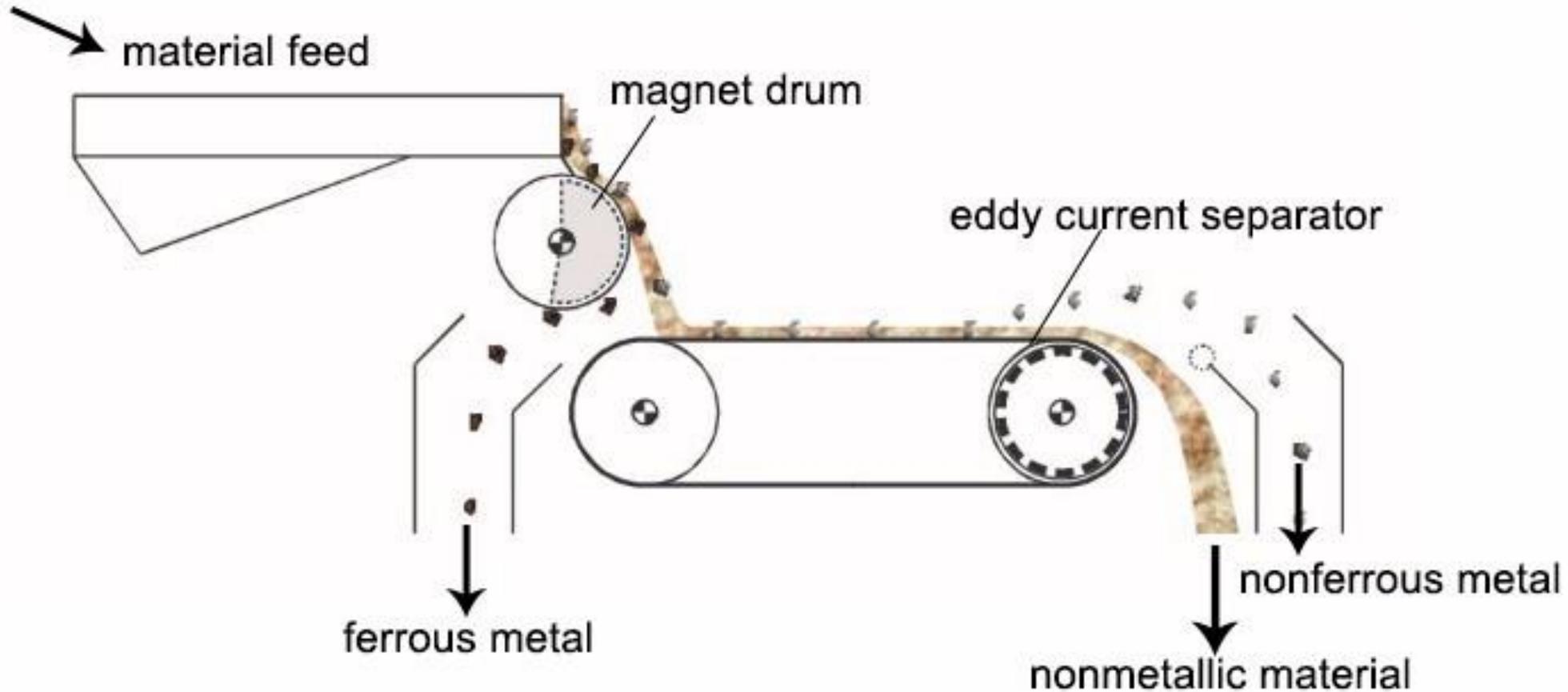
<https://www.forrec.it/prodotti/mulini-a-martelli/z15.html>



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Separatore materiali metallici – Correnti indotte



http://www.ejetmagnets.com/sdp/1295090/4/pd-5672852/20362263-2845315/Scrap_zorba_metal_sorting_system.html



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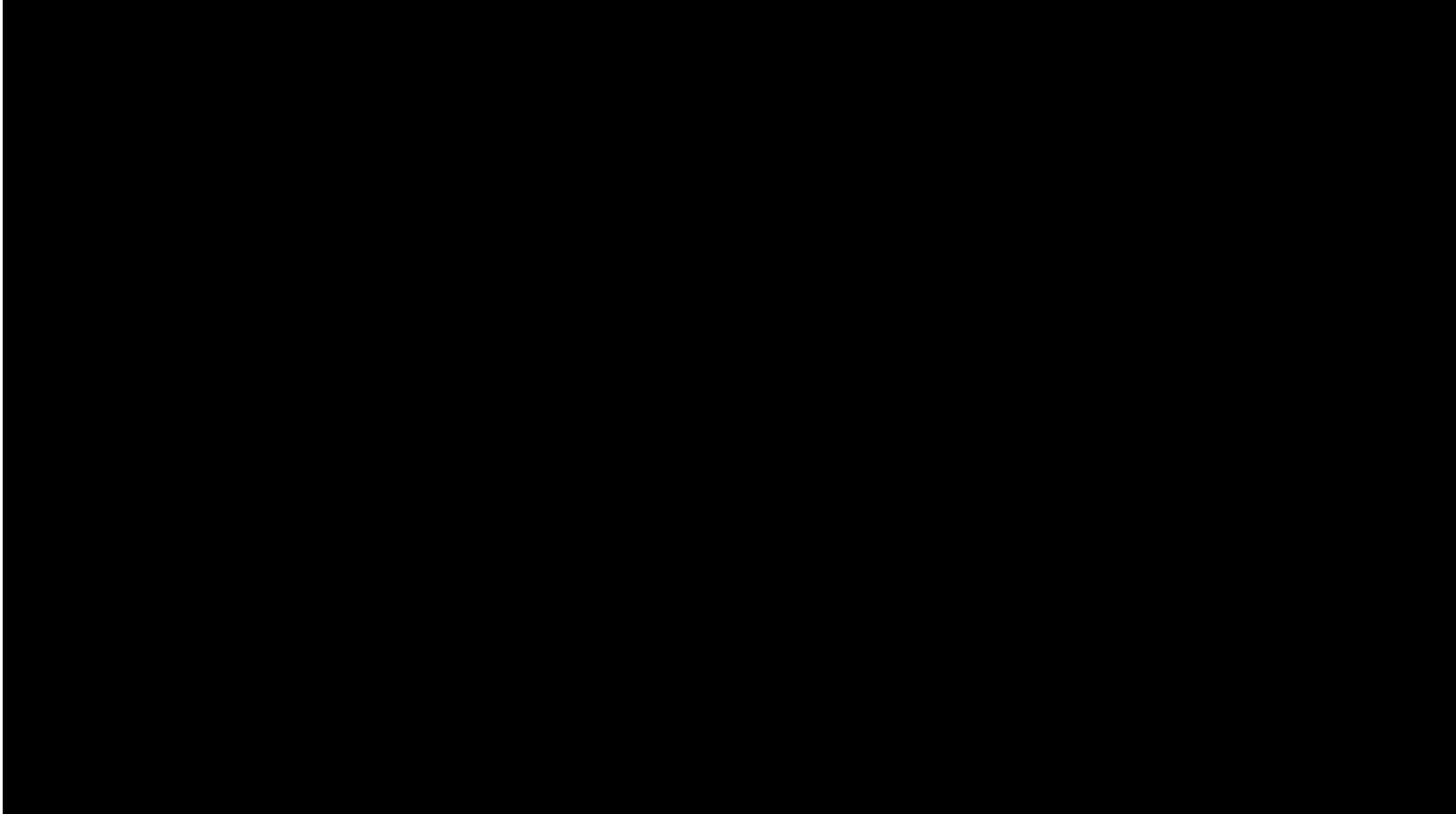


Separatore materiali metallici



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<https://ocw.tudelft.nl/course-lectures/2-2-1-pre-processing/>



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2.3 An introduction to metallurgical processes



<https://ocw.tudelft.nl/course-lectures/2-3-1-an-introduction-to-metallurgical-processes/>



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2.4 Metallurgical processes for the recycling of metals



<https://ocw.tudelft.nl/course-lectures/2-3-2-metallurgical-processes-for-the-recycling-of-metals/>



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2.6 Environmental issues (of recycling processes)



<https://ocw.tudelft.nl/course-lectures/2-4-2-environmental-issues/>



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Recupero dei materiali da Schede Elettroniche



<https://www.youtube.com/watch?v=10gUNPuAqE0>

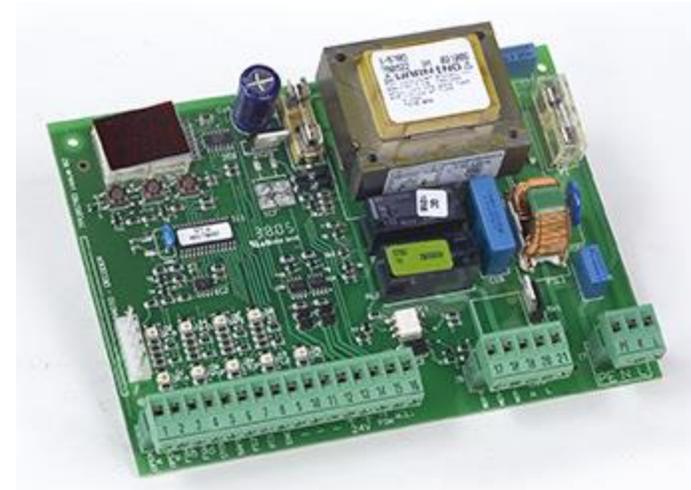
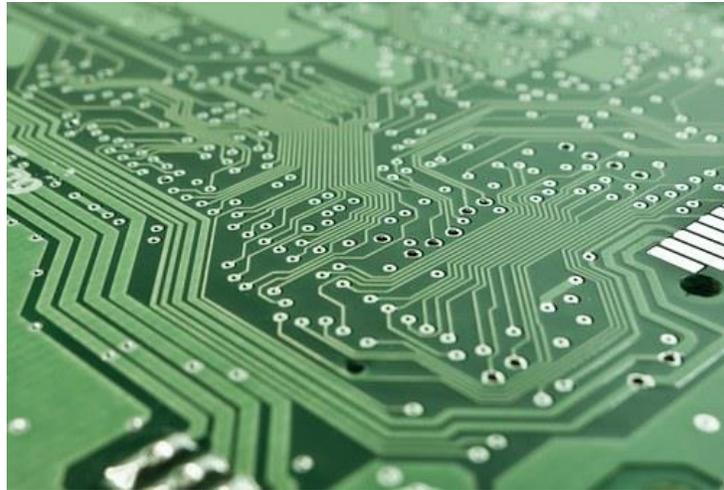


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Circuiti Stampati (PCB) e Schede Elettroniche

Un **circuito stampato** nell'elettronica, è un supporto utilizzato per interconnettere tra di loro i vari componenti elettronici tramite piste conduttive incise su di un materiale non conduttivo.



<https://www.meccanicanews.com/2017/12/19/eseti-circuiti-stampati/>

<https://www.elettroonline.it/prodotto/578d-780d-schede-elettroniche/>

Generalmente il materiale usato è una piastra di "Fiberglass" ricoperta da un sottile strato metallico. Tale strato viene successivamente intagliato con la tecnica di incisione (laser o acidi)



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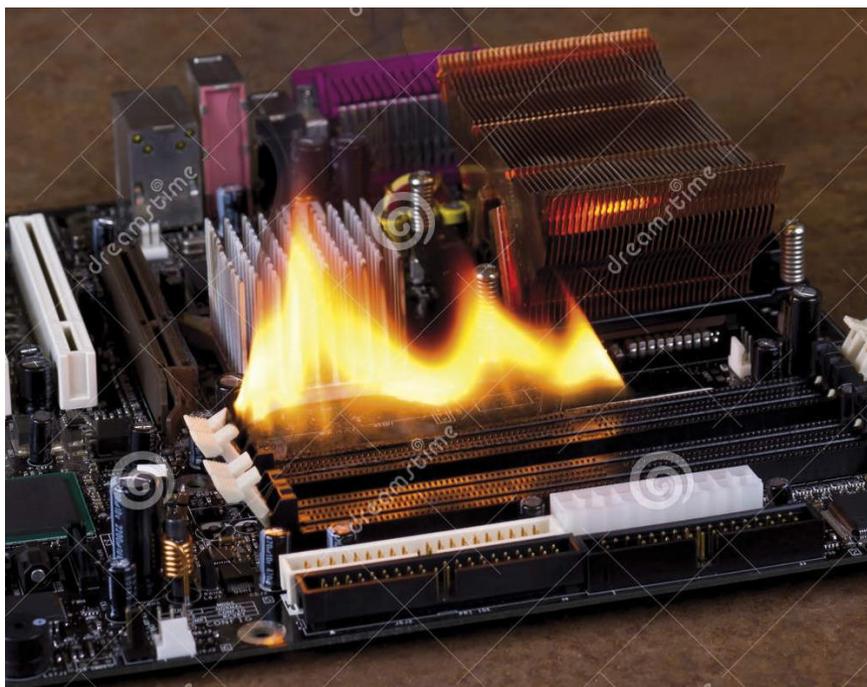
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Recupero dei materiali da una scheda elettronica

Problematiche legate all'uso di FR nei RAEE

Il **circuito stampato** viene additivato di ritardanti di fiamma FR. Composti che ritardano o impediscono la combustione accidentale ma quando decomposti rilasciano sostanze tossiche



Diossine e Furani



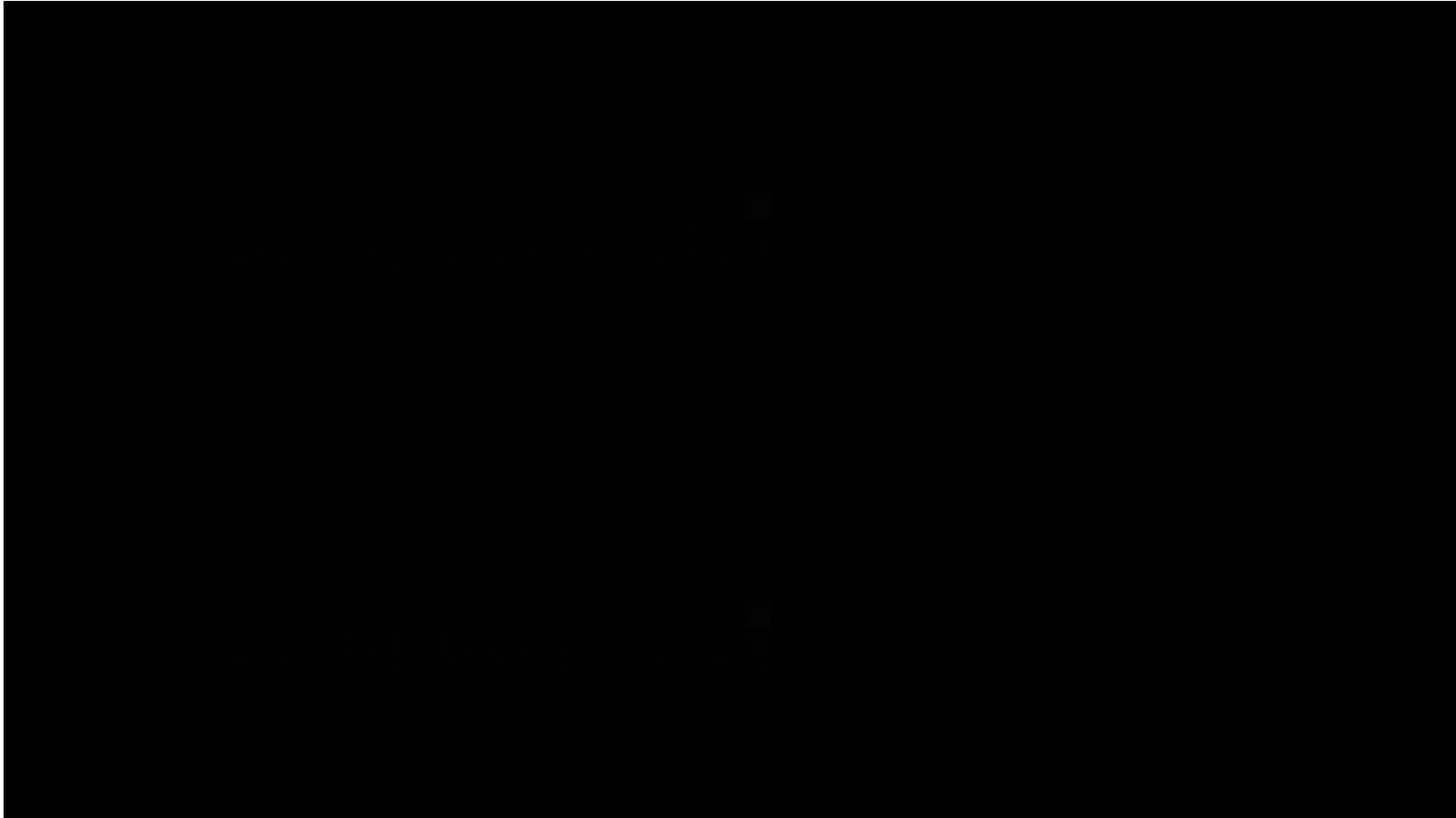
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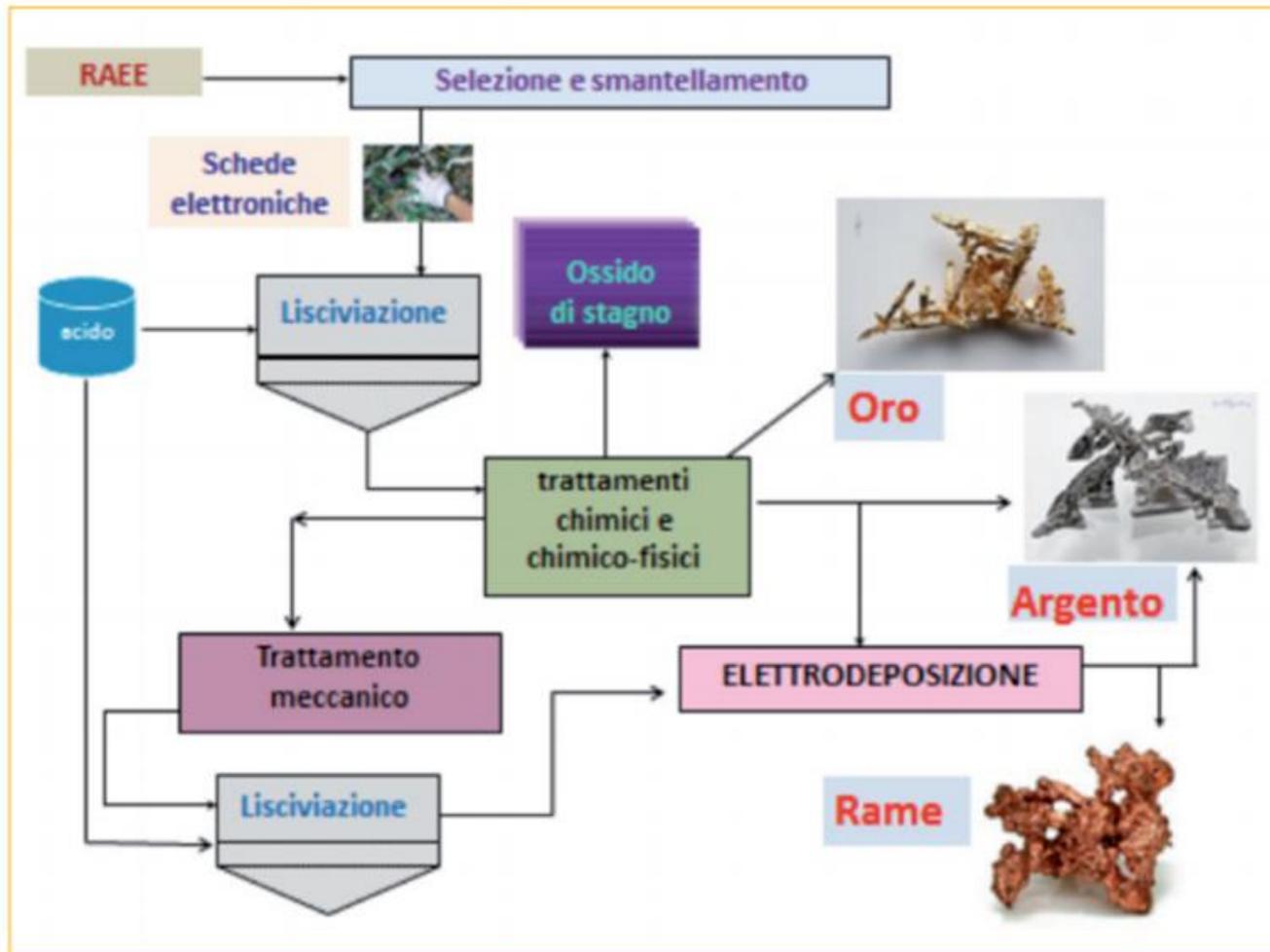
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Recupero dei metalli nobili per via idrometallurgica



Processo idrometallurgico di recupero di oro, argento, stagno e rame da schede elettroniche

	Quantità recuperata per ton di schede elettroniche	Valore commerciale indicativo (stima settembre 2013)	Valore potenziale approssimato in euro
Rame elettrolitico	260 kg	5,30 €/kg	1380
Solfato di piombo (~ 29 Kg di Pb)	40 kg	1,50 €/kg (Pb)	40
Stagno	33 kg	17,30 €/kg	570
Oro	140 g*	31,50 €/g	4410*
Argento	0,66 kg	500 €/kg	330
Totale			6730

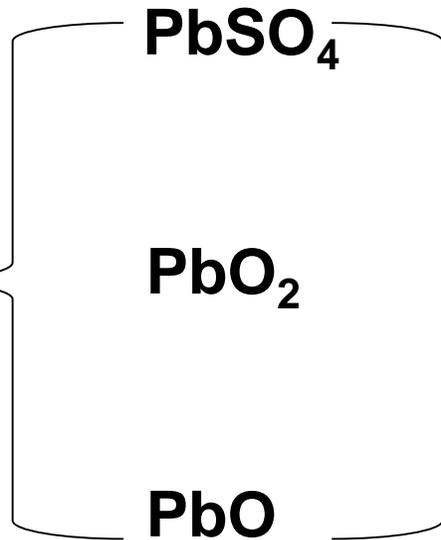
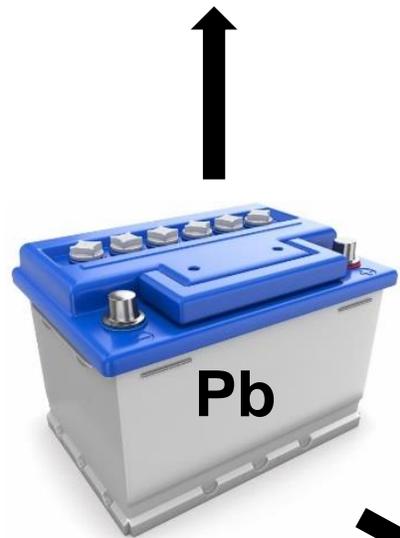
* Quantità di oro presente in schede prive di processori: con i processori tale quantità può raggiungere i 280 g totali, per un valore corrispondente di circa 8800 euro/t

<http://www.enea.it/it/seguici/publicazioni/pdf-eai/n-5-settembre-ottobre-2013/tecnologie-recupero-raee-sicilia.pdf>

Progetto EcoPiombo: recupero del Pb per via Idrometallurgica



Acido Solforico



pastello

Pirometallurgico
(1000 °C e coke)

Idrometallurgico



Pb⁰



Plastiche



Griglia Pb⁰

Rottami di Fe

Acetato di Urea



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Recupero di Terre Rare per via Idrometallurgica



I CRMs (terre rare) vengono recuperati per trattamento delle polveri fluorescenti contenute nei display CRT

RELIGHT



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Impianto pilota per il recupero di terre rare da polveri fluorescenti



**Produzione di
carbonato di Y ed Eu**





First of a kind commercial Compact system for the efficient Recovery Of COBalt Designed with novel Integrated LEading technologies



Recovering Cobalt



Il 42% del consumo mondiale di Cobalto (100.000 t/anno) è dovuto all'uso delle batterie al Li



<https://h2020-crocodile.eu/>



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