

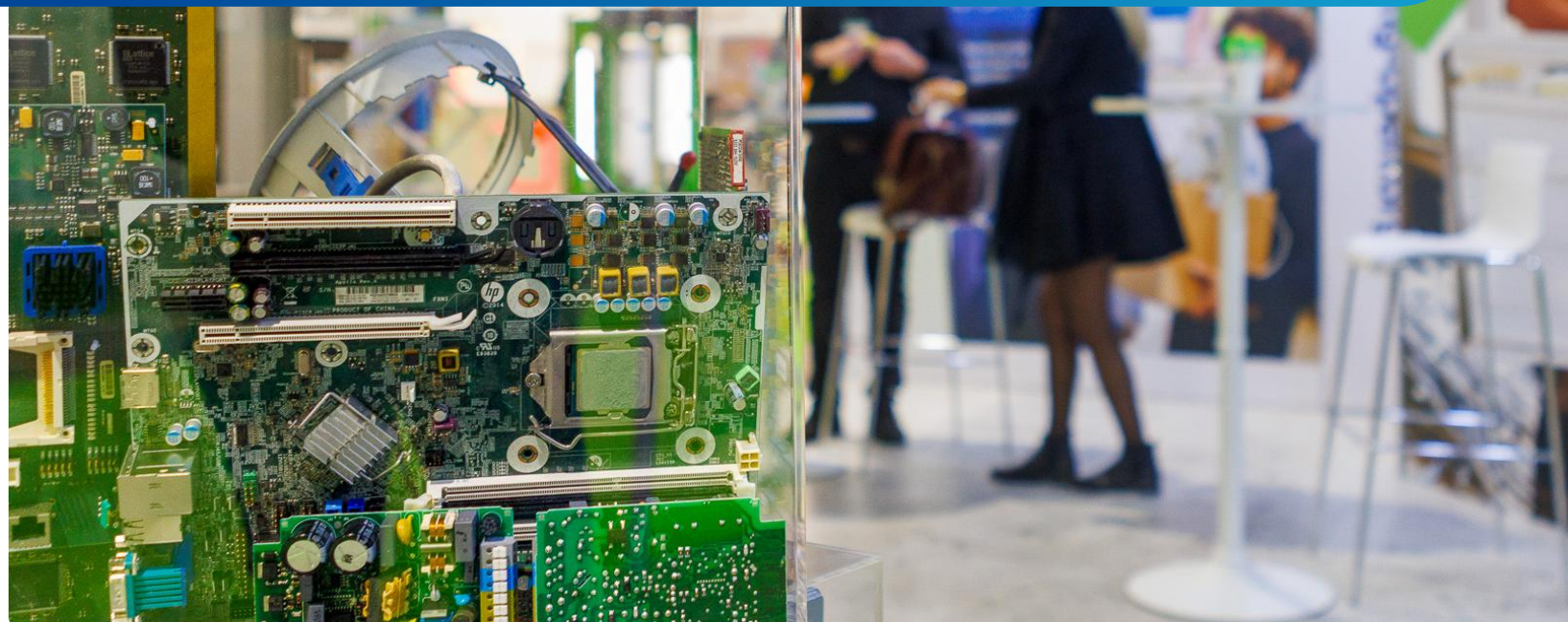


Circularity and critical raw materials

what does it take and are we willing to do this?

Circular Circuits, October 6, 2026

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Policies on circularity: what does it take and are we willing to do this?

- Legal frameworks: the main documents (after the Waste Regulations)
- E-waste and feedstock: a needle in a haystack
- Long journey to go, adventures ahead
- New capabilities: a technical perspective
- Fast lane versus slow lane
- Conclusions

Legal frameworks

WEEE Directive

- Collection targets (65%/ 85%) and recycling targets for 6 product categories (appr. 80% materials recover)
- No special requirement for critical raw materials
- Non-mandatory recycling standards (CENELEC) across the EU
- Huge differences in recycling capabilities
- From WEEE Directive to WEEE Regulation > after 2029
 - Separate targets for PV and windmills (in discussion)
 - Collection targets (in discussion)
 - Mandatory technical standards (in discussion)



Legal frameworks

Battery regulation (July 12, 2023) (blueprint for the WEEE Regulations)

- Various implementation dates: most important August 18, 2025
- Five different battery categories (different collection and recycling targets)
- Most problematic: industrials batteries and the famous “article 61”
- Recycling targets
 - Targets by weight (65% of the weight of lithium batteries in 2025, 70% in 2030 etcetera)
 - Targets by material: lithium recovery (50% recovery in 2027, 80% in 2030)
 - Cobalt recovery (90% recovery in 2027, 95% in 2030)
 - Copper (90% recovery in 2027, 95% in 2030)
 - Lead (90% recovery in 2027, 95% in 2030)
 - Nickel (90% recovery in 2027, 95% in 2030)
- Battery Regulation > great from a legal perspective > but almost impossible to implement

Legal frameworks

Circular Economy Act (proposal will be published November 11, 2026)

- Could affect the WEEE Regulations and Battery Regulations
- Scope not clear yet
- Maybe with additional requirements for critical raw materials

Critical raw materials Act (CRM Act)

- Adopted May 23, 2024
- Making Europe more resilient
 - 10% of annual consumption from domestic extraction
 - 40% of annual consumption from local processing
 - 25% of annual consumption from recycling
 - Maximum 65% import share for any strategic raw material from a single third country at any stage of processing
- Impact not clear yet

Legal frameworks

WRAP-UP

- EU regulations can change operations in the EU
- But also > very complex legislation > many years of preparations before legislation gets adopted
- If the regulations come into force > responsibility moves to the member states
- So, member states are the first ones to execute this regulations
- But member states often lack experience to move from legislation to execution in the real world
- EU wide this leads to main obstacles to implement EU regulations correctly
- So, will all this legislation fasttrack Europe in becoming more resilient?

E-waste and feedstock: a needle in a haystack

Stichting OPEN dominates the nationwide collection and recycling network for e-waste in the Netherlands:

- Stichting OPEN with partners collects and recycles 71% of the total volume of e-waste (2025)
- 250,000 tons/ year or 1,000 tons of WEEE every day, recycled conform CENELEC
- Due to the CRM Act (25% of the CRMs demands should come from waste recycling), Stichting OPEN was involved in several consortia to gain more knowledge about CRMs and also conducted our own studies



E-waste and feedstock: a needle in a haystack

So, if you collect 1000 tons of e-waste from the whole of the Netherlands every single day and concentrate this in 100 trucks.....



E-waste and feedstock: a needle in a haystack

And if you do your very best and sort out and recycle neodymium without losses, at the end of the day you have:

Challenges:

- Appliances don't have a sign stating: neodymium inside!
- A digital product passport (DPP) is of help but not enough for the current problems in the short run
- Even with a DPP, it will take 15-20 years before these products return at waste recycling facilities

150 kg of neodymium
= approx. 21 liters

Neodymium is a dense and valuable metal used in high-performance magnets.



Mass
150 kg



Volume
approx. 21 liters
(density: 7.0 g/cm³)



What does that look like?
About two 10-liter buckets filled with neodymium.



Why it matters
A small volume – high value. Every kilogram counts.



Volume comparison



150 kg neodymium
approx. 21 liters



Beverage crate
approx. 24 liters



Jerrycan (20 L)
approx. 20 liters



Car battery
approx. 15–20 liters

Long journey to go, adventures ahead

(1) Transport (dumpster containers)

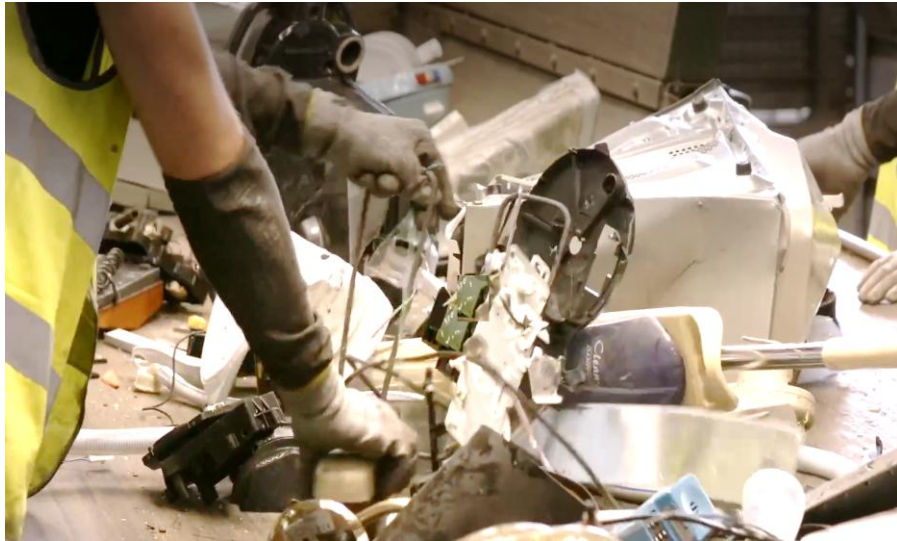


(2) Industrial sized storage facilities



Long journey to go, adventures ahead

(3) Manual sorting/ depollution (with limitations)



(4) Industrial CENELEC shredding and sorting



Picture 4 simplifies the problem: the exact moment when and where neodymium is lost:

- At the entrance of the shredder. Shredders are very important to liberate materials from appliances which will henceforward undergo further sorting activities (wind sifting, eddy currents, NIR-detection, upgrading & cleaning)
- But alas, after shredding small neodymium objects will break down, be locked into the iron fraction and are lost

New capabilities: a technical perspective

Making Europe resilient

For CRMS we need new capabilities and long-term investments. After collection, the best ways forwards are:

- 1) Detection (image recognition) and automated sorting processes of individual appliances on an industrial scale
- 2) Efficient component recovery (containing CRMs) after recognition of these CRM containing appliances. Most likely, we need a parallel creation of a CRM database of individual old-stock appliances (they don't have a DPP)
- 3) Delivering CRM feedstock components to specialized CRM recovery facilities in Europe
- 4) Don't forget the off-take > it only makes sense if European companies buy these recovered CRMs

PROs and waste recycling companies have the knowledge and experience to solve these problems. In addition, PRO systems can connect this chain of actors, collect and concentrate materials and deliver these to specialized recyclers.

To move forward at speed, we need to tap into the creativity of the e-waste sector which has day-to-day and hands-on experiences with e-waste and knowledge and expertise about the do's and don'ts to recover CRMs on an industrial scale.

Fast lane versus slow lane

Making Europe resilient

The main costs for CRMs recoveries occur for the e-waste sector and these need to be addressed:

- CRMs are critical for our energy grid, defense systems and our industrial base, in general for Europe and its member states as a whole: the beneficiaries
- The monetary value of CRMs however is not by far enough to offset these additional costs
- In Europe, we must arrange a transfer of means from the beneficiaries to the waste sector to make additional investments for CRM recovery possible and sustainable for the greater good: prosperity of Europe

In the end we have two options:

- Slow lane: waste companies & PRO systems will get additional responsibilities but without the extensive powers and financial support needed to move forward at speed. Don't forget, the costs and risks are huge
- Fast lane: PRO systems & the waste sector are challenged with generous incentives to elaborate investment plans and to execute these, supported with long-term commitments from the beneficiaries to buy these recovered CRMs

Conclusions

Making Europe resilient

- Europe can develop the required capabilities and has a great starting point
- Based upon legal frameworks, based upon strong recycling companies and PRO systems
- But don't expect that legal frameworks alone will do the trick
- To really speed-up: look to the activities of Europe's main competitors and do the same!
- In other words, take off the gloves and start playing powerplay. Copy the activities and supporting mechanisms of the governments of China, Japan, Canada, Australia, USA,.....
- Arrange a massive transfer of means to make additional investments for CRM recovery possible for the greater good: prosperity of Europe
- So, support the waste management industries as critical infrastructure instead of a problem. They are the only ones to retrieve CRMs from waste products!

stichting

