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## **Environmental sustainability of NdFeB magnet recycling: foresight study on recycling systems and technologies**

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Stellingen

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**Environmental sustainability of NdFeB magnet recycling:  
Foresight study on recycling systems and technologies**

1. The most critical step in the recycling chain of NdFeB magnets is their identification in waste flows (*Chapter 2 and 3*). Product design for disassembly, consumer participation in sorting, and digital product passports can all contribute to overcoming this barrier.
2. Increasing the recycling rate of NdFeB magnets requires an integrated view and monitoring of the entire recycling chain (*Chapter 2*).
3. The largest volumes of end-of-life NdFeB magnets are in hard drives, other electronics and industrial magnet applications (*Chapter 3*).
4. Small-scale magnet recycling by direct alloy recovery has a large environmental footprint, but this can be significantly reduced by upscaling and optimizing the processes involved, such that recycled magnets have a lower environmental impact than primary magnets. (*Chapter 4*).
5. Technological learning affects each environmental impact category differently, therefore a separate learning rate should be determined for each (*Chapter 5*).
6. As countries focus on securing critical raw materials (CRMs), it is particularly important that environmental scientists continue to monitor the impact of new mines (Kálmán & Trellevik, 2023).
7. When calculating the impacts of complex manufactured products, it is important to account for industrial buildings. The operational building energy used by these buildings can contribute significantly to the impacts (Mawson & Hughes, 2020).
8. Industrial Ecologists have an important role in establishing a circular economy for metals: to reveal urban mines and new recycling opportunities (Fet & Deshpande, 2023).
9. More research is needed on integrated social and environmental LCA, as this can steer corporate sustainability reporting practices towards scientifically sound methods (Stewart et al., 2018), while supporting the interdisciplinary nature of Industrial Ecology.
10. The quality of an extrapolation depends not only on the input data, but equally on the theoretical basis on which the extrapolation is justified.
11. If people spent more time enjoying nature, they would have less time to buy and use products that cause environmental degradation.

**Sander van Nielen**  
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