



Recycling REEs in Hard Disk Drives: The case of Hitachi Group

MOOC “Critical Raw Materials: Managing Resources for a Sustainable Future”

Based on: Cimprich A, Young S B, Schrijvers D, Ku A Y, Hagelüken C, Christmann P, Eggert R, Habib K, Hirohata A, Hurd A J, Lee M-H, Peck D, Petavratzi E, Tercero L, Wäger P, Hool A (under review): The role of industrial actors in the circular economy for critical raw materials: A framework with case studies across a range of industries.

The rare earth elements (REEs) neodymium and dysprosium are used in permanent magnets, which are considerably stronger than conventional magnets. Hitachi Group has developed and implemented a technology to efficiently separate REE permanent magnets from waste electrical and electronic equipment (WEEE), such as computer hard disk drives (HDDs).

The circularity strategy works as follows:

- Hitachi Group companies and regional affiliates manage a nationwide WEEE collection program.
- The collected HDDs are disassembled in facilities affiliated with Hitachi Group, using specialized equipment designed by Hitachi Group (see Figure 1):
 - a) First, the HDDs are placed in a machine with a rotating drum that generates repeated shocks and vibrations that loosen the HDDs’ mechanical fasteners so that the component parts get separated. Specially designed through-holes in the drum of the disassembly machine allow voice coil motors containing the permanent magnets to pass through with minimal damage, thus maximizing material recovery.
 - b) Another machine separates scrap materials such as ferrous metals, aluminum, glass, and circuit board fragments containing precious metals from the HDD components.
 - c) A third machine recovers the permanent magnets from the voice coil motors that were recovered from the HDD disassembly machine.
- Finally, the recovered magnets are sent to magnet manufacturers both within and outside of Hitachi Group. In the case of Hitachi Group magnet manufacturers, neodymium and dysprosium are extracted and recycled into new magnets that can be incorporated into new HDDs.

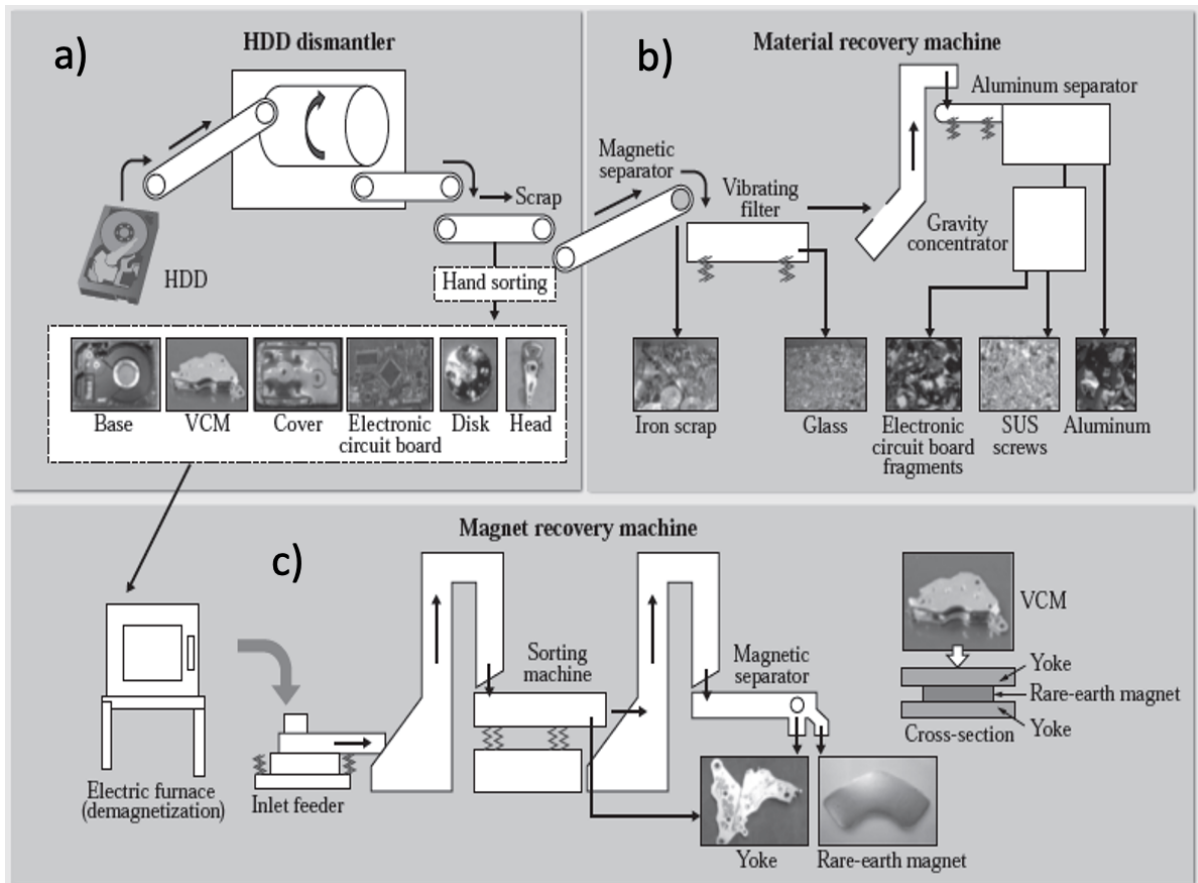


Figure 1: Hitachi Group’s process used to disassemble HDDs and recover Rare Earth permanent magnets, steps a)-c). HDD: Hard Disk Drive; VCM: Voice Coil Motor; SUS: Stainless Steel. Baba et al. (2013).

Hitachi Group therefore pursues a closed-loop circularity strategy, where magnets are recycled in-house into new magnets for their HDDs, as well as an open-loop circularity strategy, in which the material leaves the product system of Hitachi Group’s HDD magnets and is sold to other magnet manufacturers who recycle the material back into new magnets for various uses (see Figure 2).

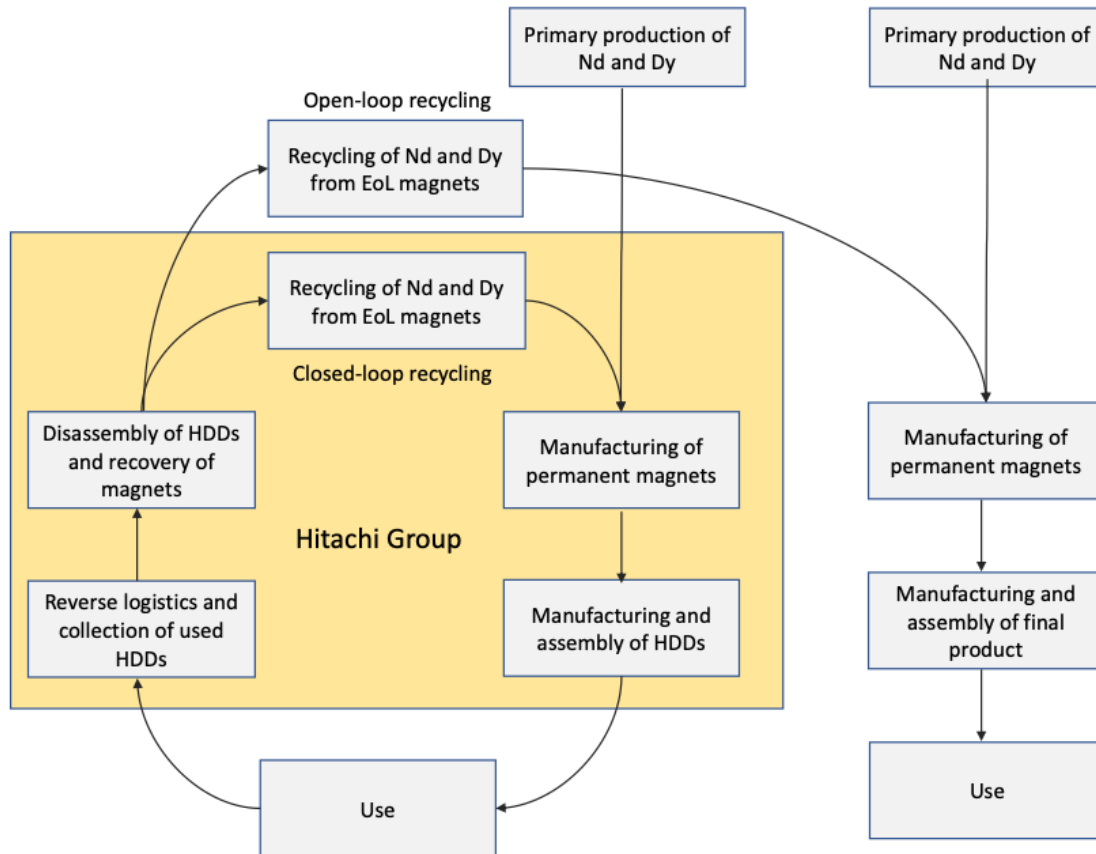


Figure 2: Depiction of the open- and closed-loop system for neodymium and dysprosium used in permanent magnets for HDDs at Hitachi Group. Steps within the yellow box are the processes in control of Hitachi group. Cimprich et al. (under review).

To create a circular system, Hitachi Group has expanded its role in the value-chain to include collection and disassembly of products at their end-of-life. This is still rarely done for consumer electronics, where products are sold in a business-to-consumer (B2C) market and end up in private and geographically dispersed use. The associated added cost often creates a barrier to adoption of circularity strategies. In the case of Hitachi Group, government support helped to implement a circularity strategy that required major structural adjustments to coordinate the logistics needed for the recovery process of the materials in question. The Japanese *Act on Recycling of Specified Kinds of Home Appliances* (2013) and the *Basic Act on Establishing a Sound Material-Cycle Society* (2000) were enabling factors, providing incentives via regulation and subsidies.



In the meantime, experience and technical advances reduced the cost of the involved steps, so that the system has become cost-effective and all of Hitachi Group's subsidiaries involved in the process are working economically. For example, the rotating drum machine enables a major improvement in the efficiency of the disassembly process: whereas manual disassembly can be done at a rate of about 10-12 HDDs per worker per hour, the automated process disassembles about 140 HDDs per worker per hour.

The recycled material also bolsters supply security for Hitachi Group. Today, material recovery and recycling fulfill about 10% of Hitachi Group's total demand for REEs used in permanent magnets.

Further Reading

Baba K, Hiroshige Y, Nemoto T (2013): Rare-earth magnet recycling. Hitachi Review 62.
https://www.hitachi.com/rev/pdf/2013/r2013_08_105.pdf

Harada Y, Nemoto T (2020): Hitachi's experience with increasing circularity of rare earth elements. Talk at the IRTC-Business Round Table on "Building resilient economies – the role of policy", November 17, 2020.
https://www.researchgate.net/publication/349883202_Building_resilient_economies_-_the_role_of_policy

Nemoto T, Matsumoto N, Kawakami N, et al (2019): Collection service and recycling technology for information and telecommunications electronics. Hitachi Review 68.
https://www.hitachi.com/rev/archive/2019/r2019_05/05b05/index.html