



2nd Seminar – Delft, the 6th December 2022

From EoL products to the manufacturing of new magnets

V. Decottignies – SUEZ - Paris



Co-funded by the
European Union



EIT RawMaterials, initiated and funded by the EIT, a body of the European Union, is the largest consortium in the raw materials sector worldwide. Its vision is to develop raw materials into a major strength for Europe. Its mission is to enable sustainable competitiveness of the European minerals, metals, and materials sector along the value chain by driving innovation, education, and entrepreneurship.



GENERAL DESCRIPTION – MAIN FEATURES

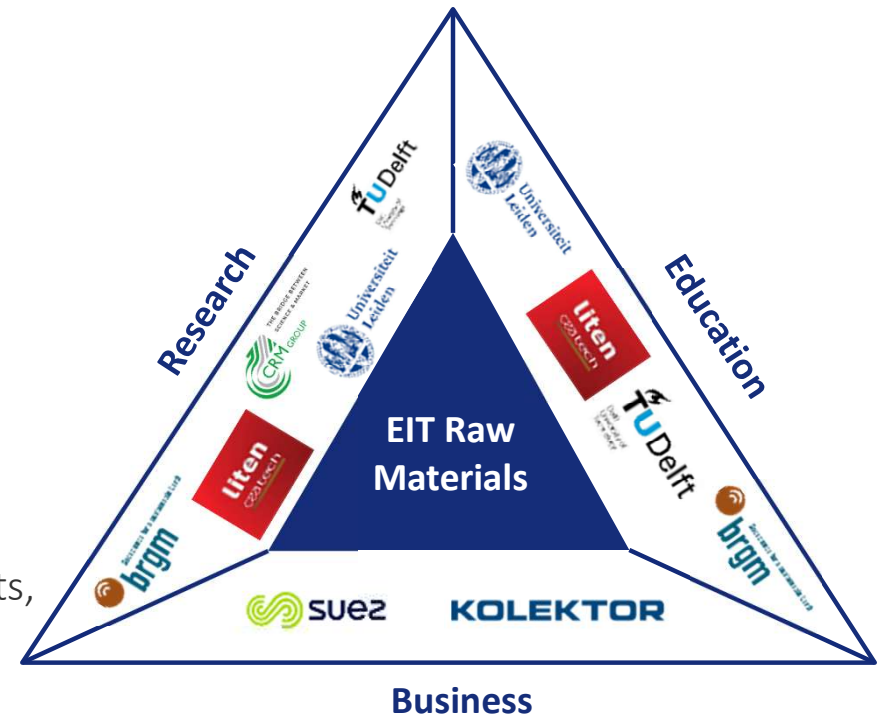
VALOMAG – Value of Magnets from Waste

- Project number: 19049
- Project budget: 2 526 102 €
- Start date: February 2020
- Project duration: 36 months
- Area: D2 Acceleration
- Activity: D2.2 Upscaling
- Strategic objective: Designing materials solutions
- Thematic fields: Recycling and material chain optimization for End-of-Life products



AGENDA

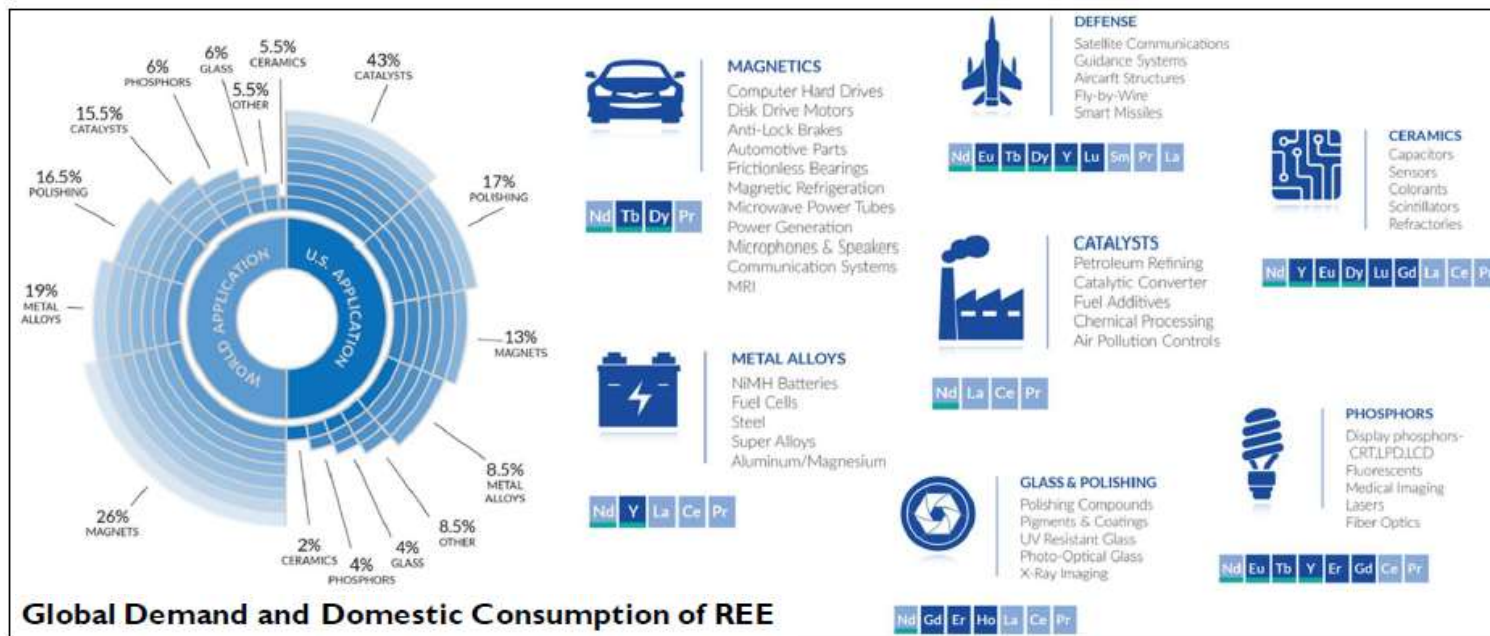
1. Background on Rare Earth Elements
2. Objective of VALOMAG project
3. Synthesis of the market study
4. Sourcing of EoL products containing magnets
5. VALOMAG Process chart:
 - From dismantling of EoL products
 - To the recovery of REE oxides and the recycling of magnets,
 - Supported by LCA and MFA



BACKGROUND ON RARE EARTH ELEMENTS (REE)



- REE = set of 17 metallic elements including: 15 lanthanides, Scandium and Yttrium
- 95% of global REE-production in China (Strategic forum/ EC Input 2018) => 85 – 90% supply of REE in Europe
- Permanent magnets = alloys of Neodymium-Iron-Boron (NdFeB)

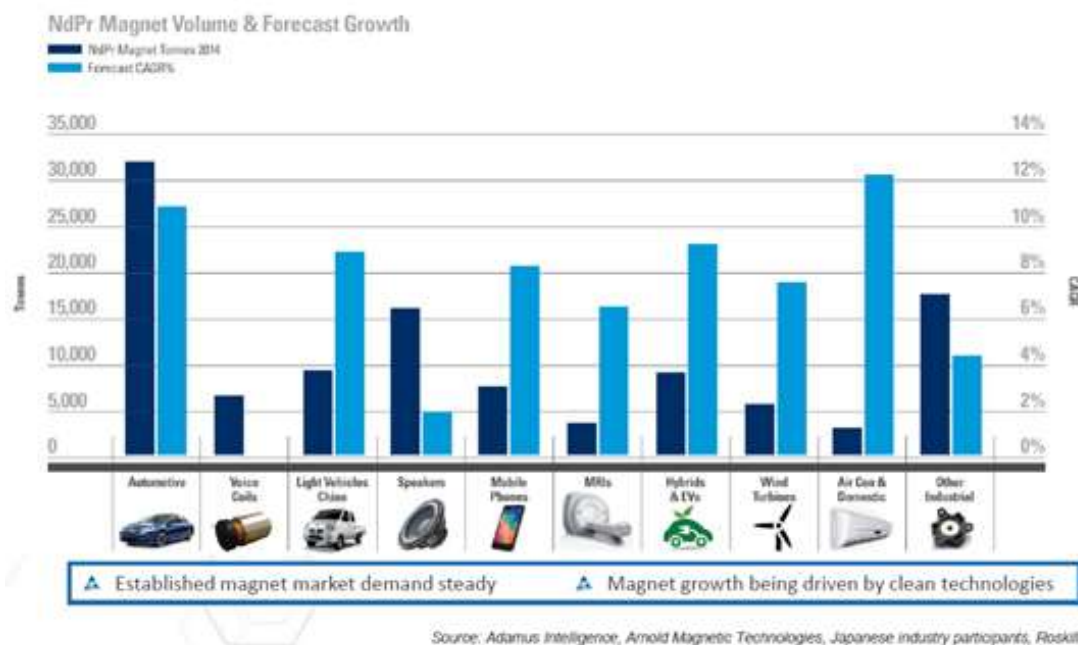


Source: National Energy Technology Laboratory (NETL), "REE-CM Program," <https://www.netl.doe.gov/coal/rare-earth-elements/program-overview/background>.

BACKGROUND ON RARE EARTH ELEMENTS (REE)

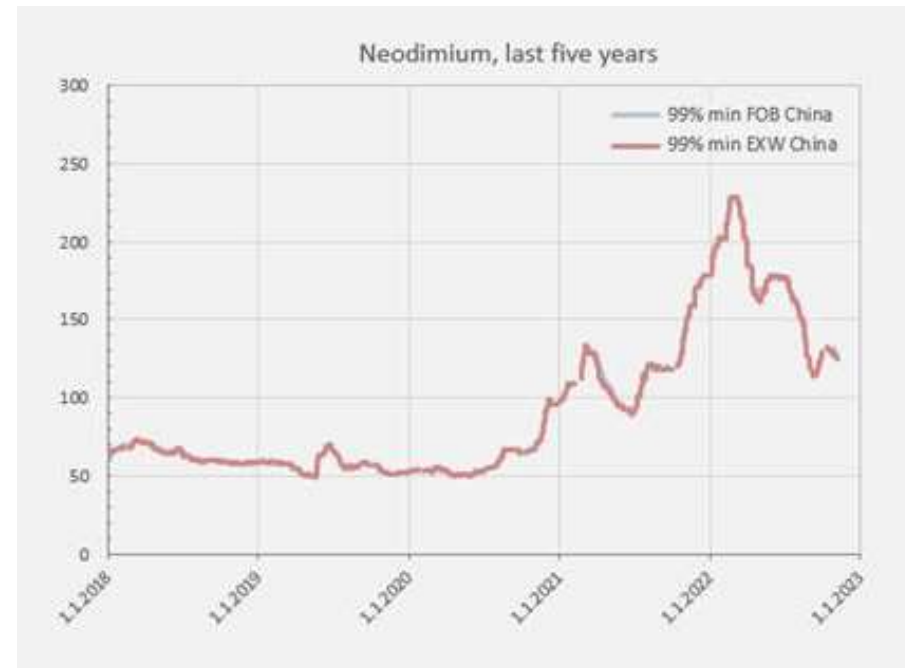


- Increasing demand of CRM like REE for Permanent Magnets in
 - Clean energy applications (wind turbine)
 - Electromobility
 - New technologies
- Significant growth already recorded and forecasted for electric vehicles: e-bikes, BEV and PHEV, due to regulation and incentives in some EU countries
- Strong growth expected for wind turbines and air-cooling systems (industrial and domestic)



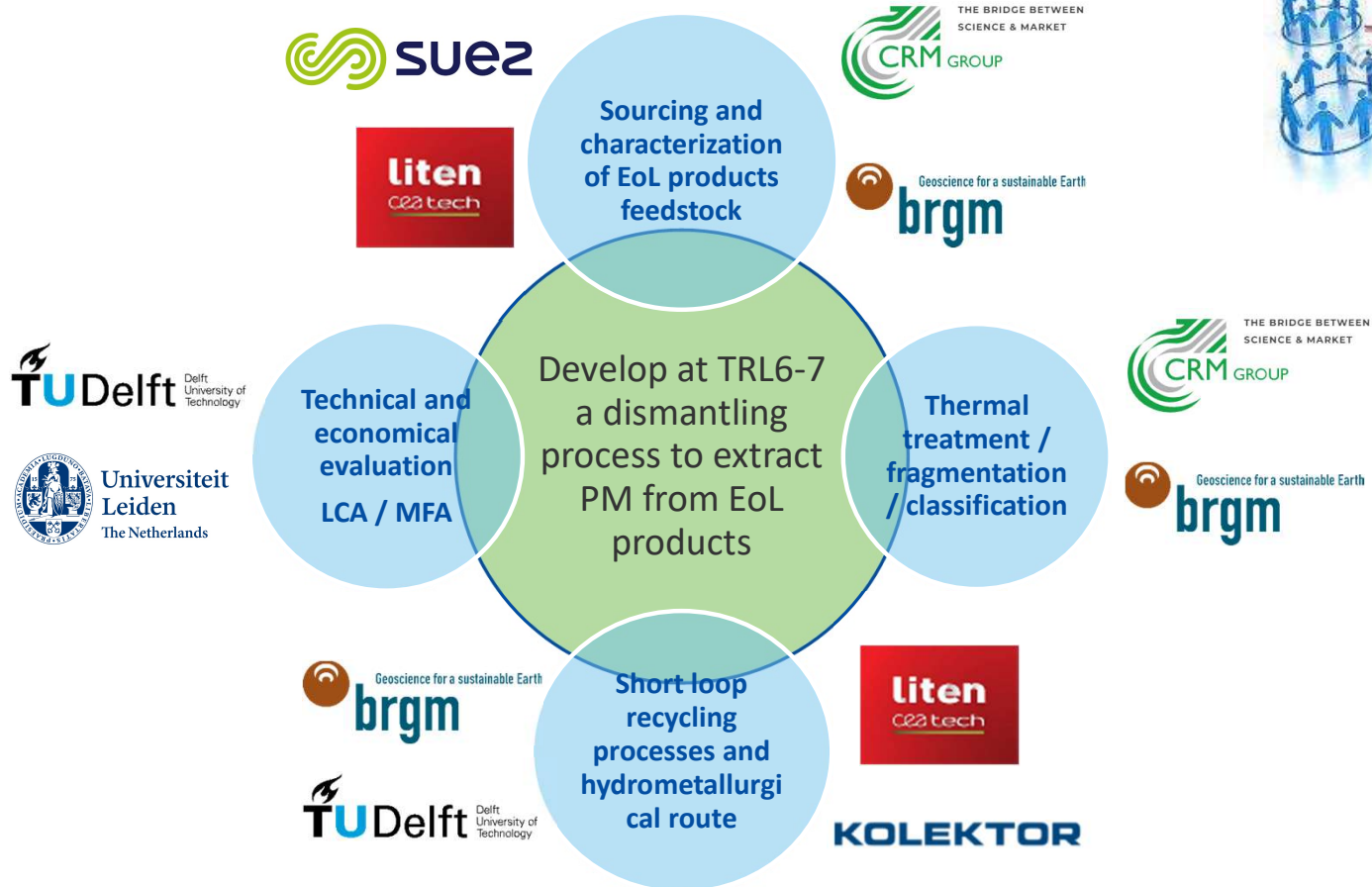
BACKGROUND ON RARE EARTH ELEMENTS (REE)

- Significant volatility in REE prices with a considerable impact across the entire value chain
 - =>From REE separations to magnets producers
- REE considered as “strategic” materials by EU for the recycling of CRM as a secondary supply
- European Union support Innovation and Research (Strategic Forum / EC 2018) through funding of projects
 - => Prioritization of actions in EU for innovative applications
- Foundation of European Raw Materials Alliance (ERMA) with 2 clusters focusing on Rare earth Magnets & Motors + Materials for Energy Storage and Conversion



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OBJECTIVE OF VALOMAG PROJECT



SYNTHESIS OF THE MARKET STUDY

DATA AND HYPOTHESES USED FOR FORECASTS CALCULATION

	Weight PM (g/unit)	NdFeB/PM (%)	Lifespan (years)	Collection Rate (%)
HDD (2.5" & 3.5")	3.5 - 11.4	30	6 and 15	66% and 90%
Air conditioners	300	30	15	42.5%
Wind Turbines Direct drive - mid & high speed	650 kg/MW 160 & 80kg/MW	30	25	100%
E-vehicles	2000	30	15	100%
E-bikes	270	30	5	90%

Sources:

- Ademe, 2020. Avis Technique - Terres rares, énergies renouvelables et stockage d'énergie
- Dańczak A, Chojnacka I., Matuska S., Marcola K, Leśniewicz A., Wełna M., Żak A., Adamski Z., Rycerz L., 2017. The recycling-oriented material characterization of hard disk drives with special emphasis on NdFeB magnets.
- Forti V, Baldé C. P., Kuehr R., Bel G., Nov 2020. The Global E-waste Monitor 2020 – Quantities, flows, and the circular economy potential
- Pavel C., Lacial-Arántegui R., Marmier A., Schüller D., Tzimas E., Buchert M., Jenseit W., Blagoeva D., 2017, Substitution strategies for reducing the use of rare earths in wind turbines. 52 (2017) 349-357
- Reimer M.V., Schenk-Mathes H.Y., Hoffmann M.F. and Elwert T., 2018 Recycling Decisions in 2020, 2030, and 2040—When Can Substantial NdFeB Extraction be Expected in the EU? Metals 2018, 8, 867 (doi:10.3390/met8110867)



SYNTHESIS OF THE MARKET STUDY

FORECASTS OF EOL PM AND Nd FEEDSTOCKS FROM 2020 TO 2040 IN EUROPE

Feedstock of EoL NdFeB Permanent Magnets in Europe

(tons)	2020	2025	2030	2035	2040
HDD (6y) 66%	580*	350	370	(440)**	(480)**
HDD (15y) 66%	440*	640	500	340	400
Wind Turbines	-	1	10	1350	1700
Air conditioners	(450)**	(500)**	565	750	nd
E-vehicles	-	5	330	4460	8000
E-bikes	405	1000	2970	4590	nd

* HDD – data in 2021 – collection rate 66%

** Estimation projected

nd – no data

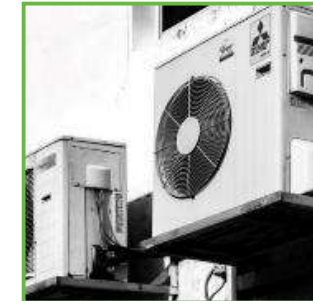
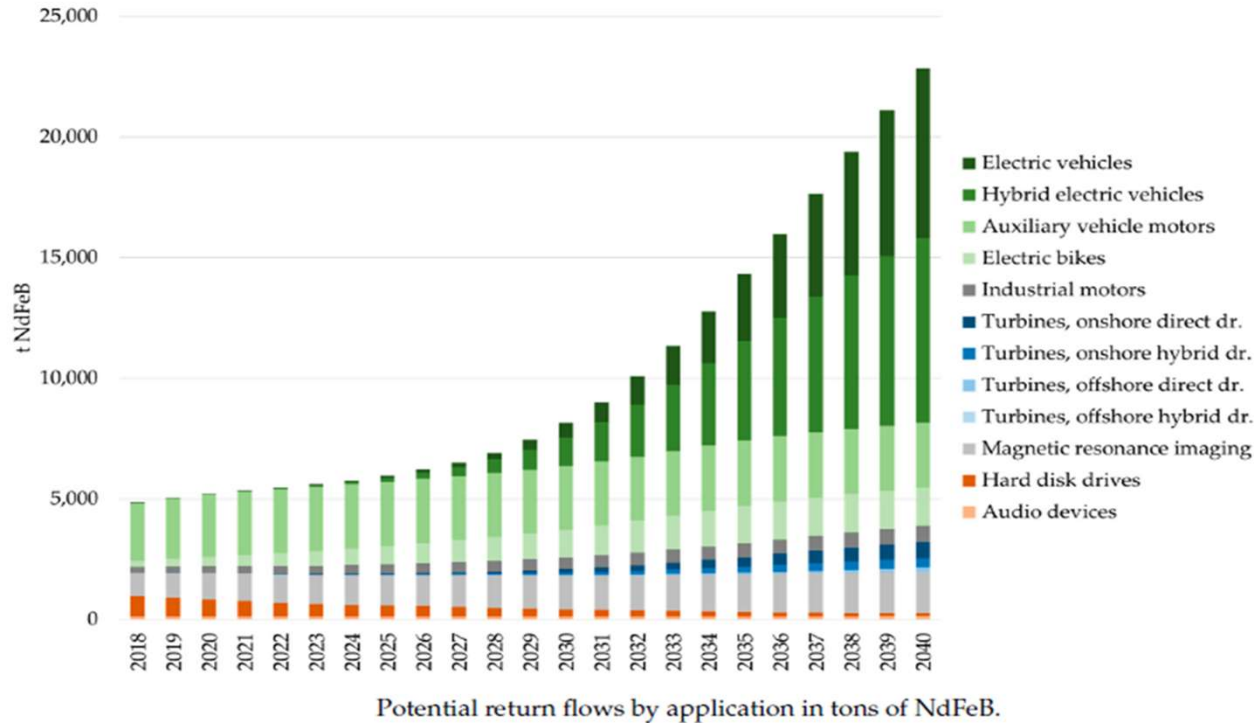
Feedstock of secondary source of Nd in Europe

(tons)	2020	2025	2030	2035	2040
HDD (6y)	174	105	111	132	144
HDD (15y)	132	192	150	102	120
Wind Turbines	-	0,3	3	405	510
Air conditioners	135	150	169,5	225	nd
E-vehicles	-	1,5	99	1338	2400
E-bikes	121,5	300	891	1377	nd



SYNTHESIS OF THE MARKET STUDY

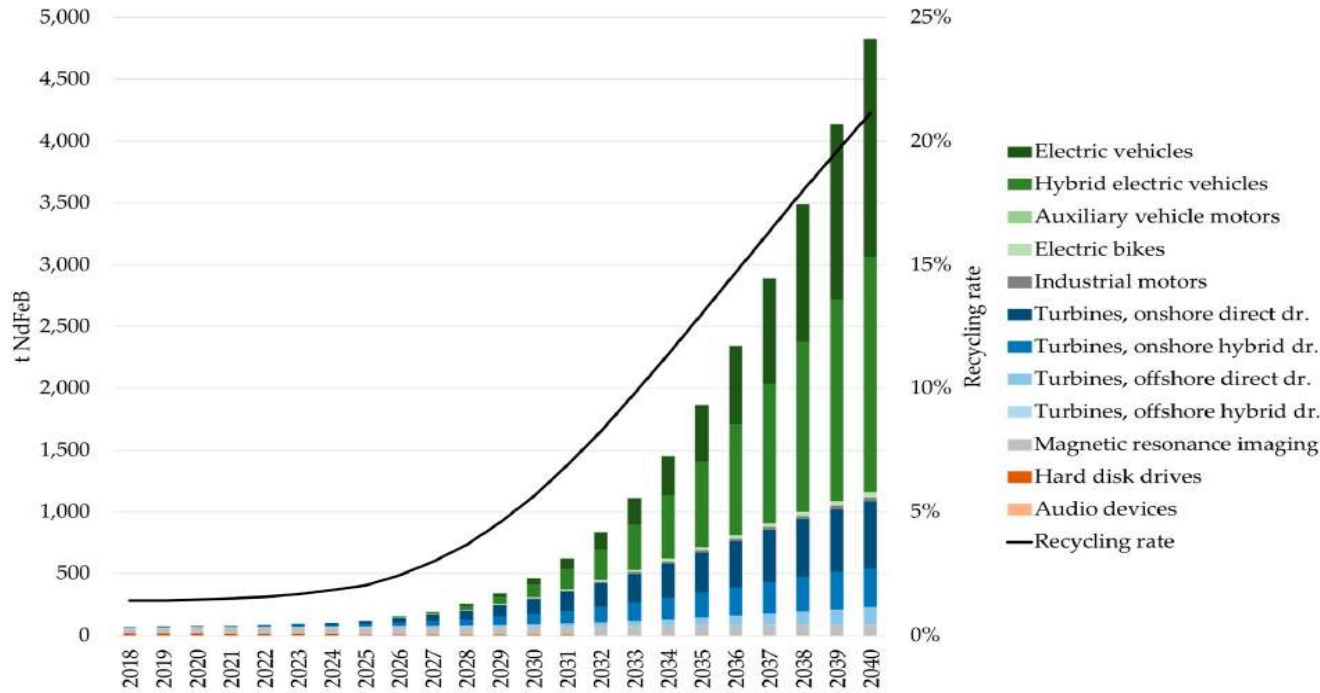
FORECASTS OF EOL PM AND Nd FEEDSTOCKS FROM 2020 TO 2040 IN EUROPE



Source: Reimer M.V., Schenk-Mathes H.Y., Hoffmann M.F. and Elwert T., 2018 Recycling Decisions in 2020, 2030, and 2040—When Can Substantial NdFeB Extraction be Expected in the EU? Metals 2018, 8, 867 (doi:10.3390/met8110867)

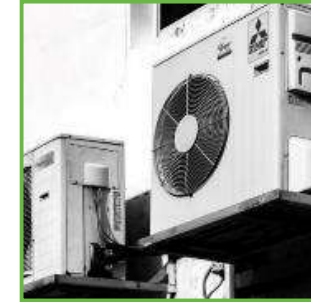
SYNTHESIS OF THE MARKET STUDY

FORECASTS OF EOL PM AND Nd FEEDSTOCKS FROM 2020 TO 2040 IN EUROPE



Estimation of the realistic return flows by application in tons of NdFeB and overall recycling rate.

Source: Reimer M.V., Schenk-Mathes H.Y., Hoffmann M.F. and Elwert T., 2018 Recycling Decisions in 2020, 2030, and 2040—When Can Substantial NdFeB Extraction be Expected in the EU? *Metals* 2018, 8, 867 (doi:10.3390/met8110867)



SOURCING OF EOL PRODUCTS CONTAINING MAGNETS



Hard Disc Drives



2 types of Magnets used in Wind Turbine Motors



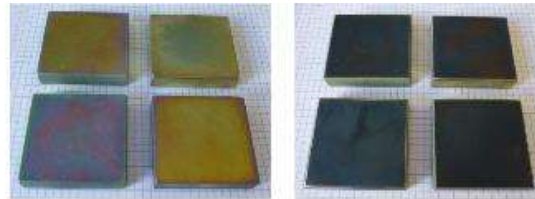
E-motors from Lexus cars



Rotors of E-scooters

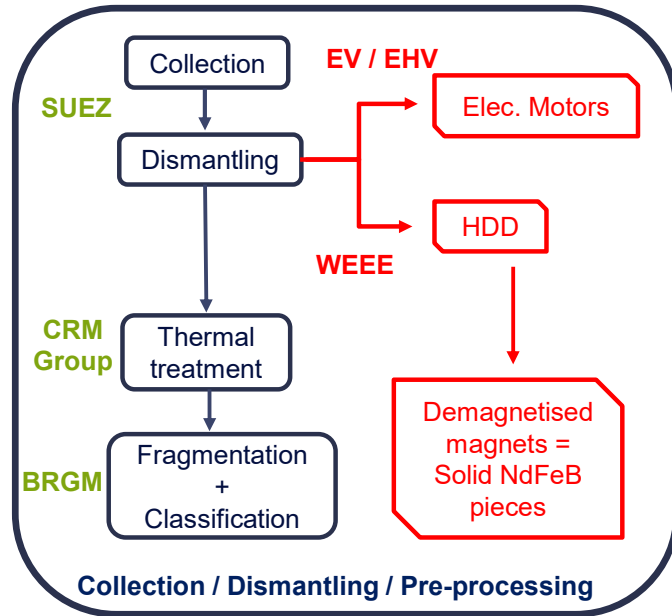


HDD (2003)



<https://www.sogaenergyteam.com/de/focus-sogaenergies-permanent-magnet-generator-wind-turbines/>

VALOMAG PROCESS CHART: FROM THE DISMANTLING OF EOL PRODUCTS

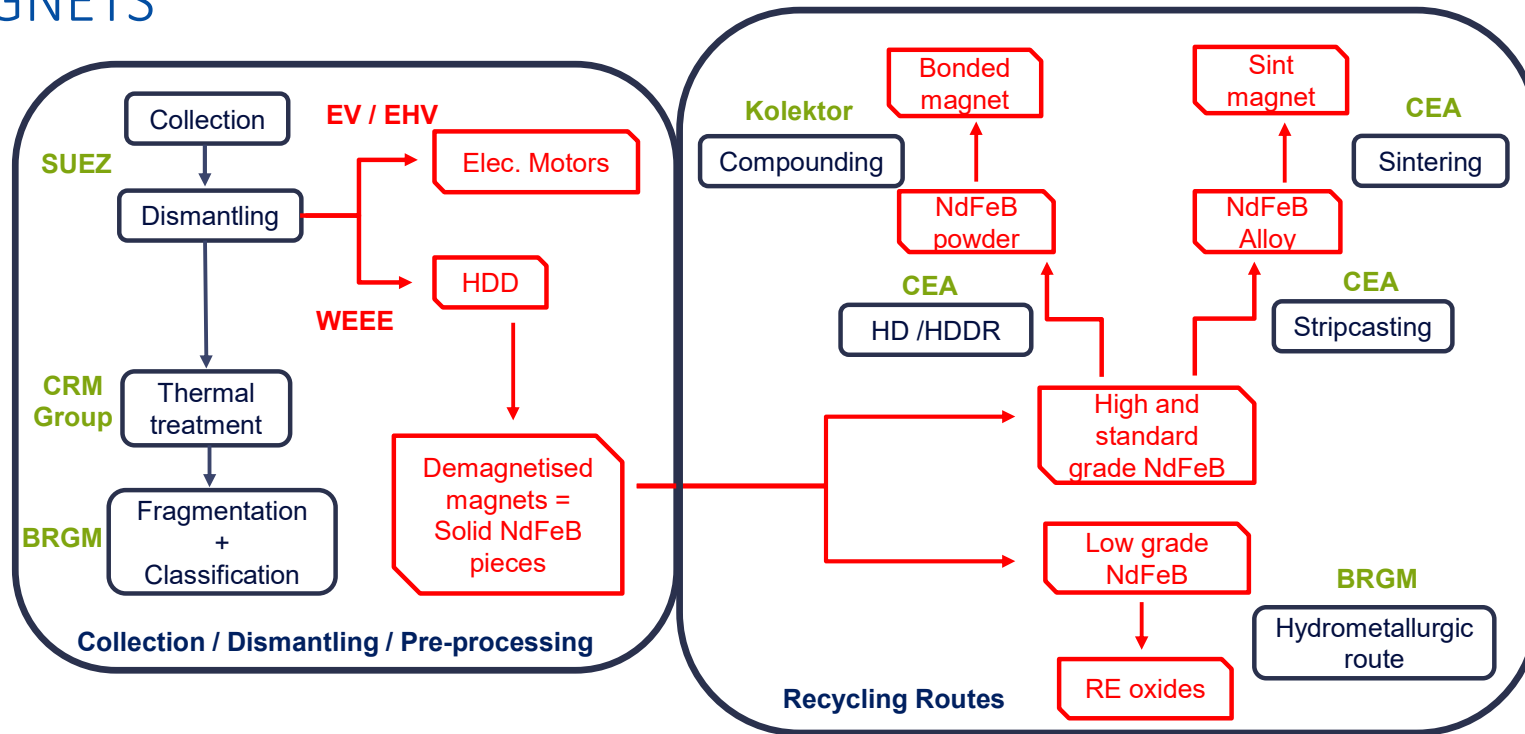


Legend: Partner involved

Materials

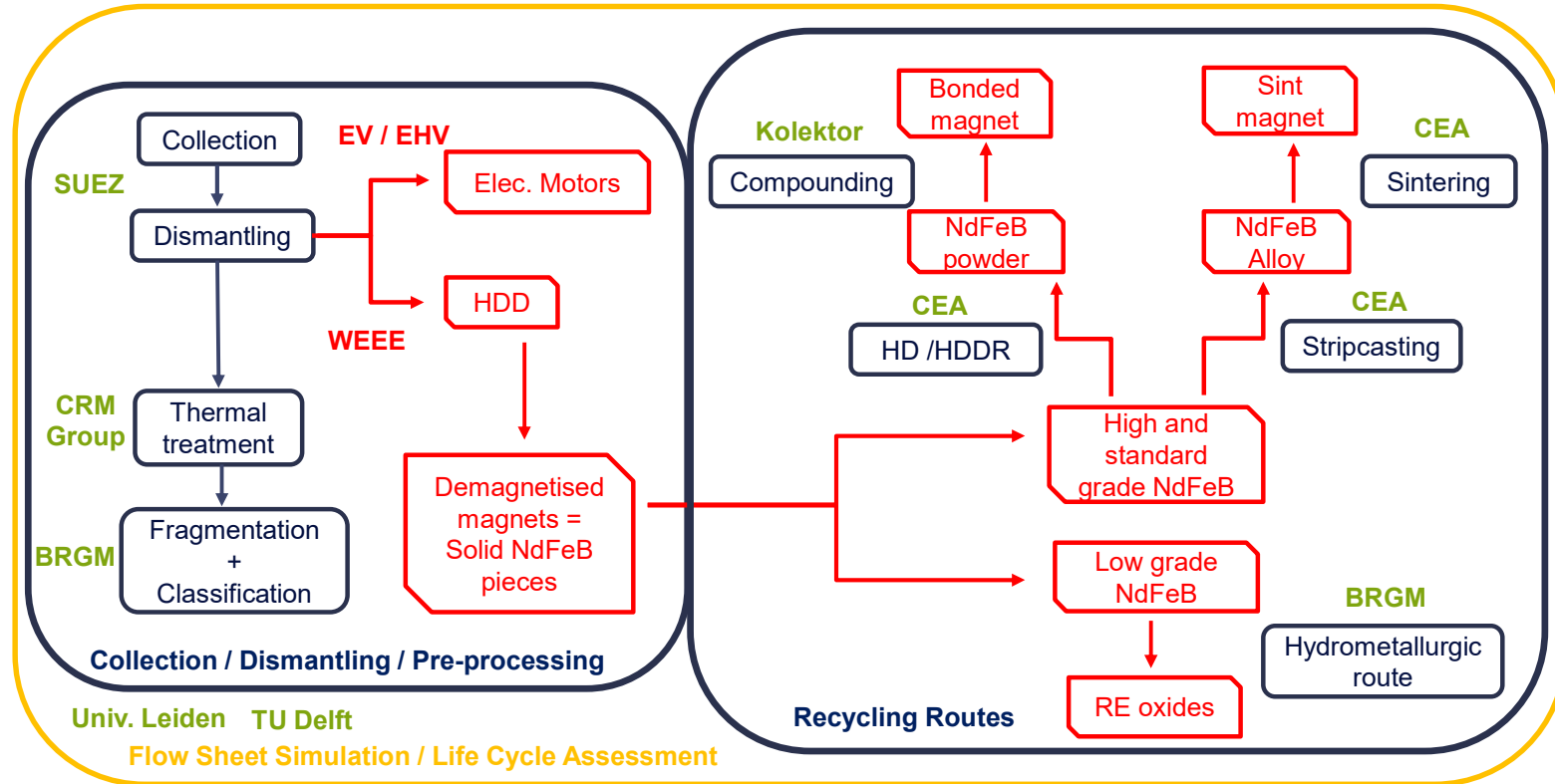
Process step

VALOMAG PROCESS CHART: TO THE RECOVERY OF REE OXIDES AND RECYCLING OF MAGNETS



Legend: Partner involved (green text), Materials (red box), Process step (black box)

VALOMAG PROCESS CHART: SUPPORTED BY LCA AND MFA





THANKS FOR YOUR ATTENTION!



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