NEO-CYCLE – insight into the project

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Warsaw University of Technology (WUT)
17th November 2025

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What is the project about?

Type of action:	**HORIZON-RIA**
Project name:	**UPCYCLING OF NdFeB MAGNETS IN THE EU FOR GREEN APPLICATIONS**
Project acronym:	**NEO-CYCLE**
Call:	**HORIZON-CL4-2023-TWIN-TRANSITION-01 (lump sum)**
Project starting:	**1 September 2024**
Project duration:	**48 months**
Participants:	**23**
Coordinator:	**IDENER**

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What is the project about?

#	PARTICIPATING ORGANIZATION	COUNTRY
1	IDENER RESEARCH & DEVELOPMENT AGRUPACION DE INTERES ECONOMICO	SPAIN
2	TECHNISCHE UNIVERSITAET BERGAKADEMIE FREIBERG	GERMANY
3	FRAUNHOFER GESELLSCHAFT ZURFORDERUNG DER ANGEWANDTEN FORSCHUNG EV	GERMANY
4	UNIVERSITAT POLITECNICA DE CATALUNYA	SPAIN
5	UNIVERSITÀ DI TORINO	ITALY
6	FLAMMA S.P.A.	ITALY
7	WARSAW UNIVERSITY OF TECHNOLOGY	POLAND
8	RMF TECH GMBH	GERMANY
9	VYTAUTO DIDZIOJO UNIVERSITETAS	LITHUANIA
10	L'UREDERRA, FUNDACION PARA EL DESARROLLO TECNOLOGICO Y SOCIAL	SPAIN
11	LC INNOCONSULT INTERNATIONAL	HUNGARY
12	NON-GOVERNMENTAL ORGANIZATION AGENCY OF EUROPEAN INNOVATIONS	UKRAINE

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#	PARTICIPATING ORGANIZATION	COUNTRY
13	FRAUNHOFER AUSTRIA RESEARCH GMBG	AUSTRIA
14	ASOCIATIA DE STANDARDIZARE DIN ROMANIA	ROMANIA
15	CONFEDERAZIONE GENERALE DELL AGRICOLTURA ITALIANA	ITALY
16	HOLOSS – HOLISTIC AND ONTOLOGICAL SOLUTIONS FOR SUSTAINABILITY, LDA.	PORTUGAL
17	ECORESET SA	GREECE
18	STENA RECYCLING SRL	ITALY
19	UNIVERSITA DEGLI STUDI DI PAVIA	ITALY
20	IBERIAN SUSTAINABLE MINNING CLUSTER	SPAIN
21	ECOCASTULUM SL	SPAIN
22	CASALE SA	SWITZERLAND
23	REGIONE LOMBARDIA	ITALY

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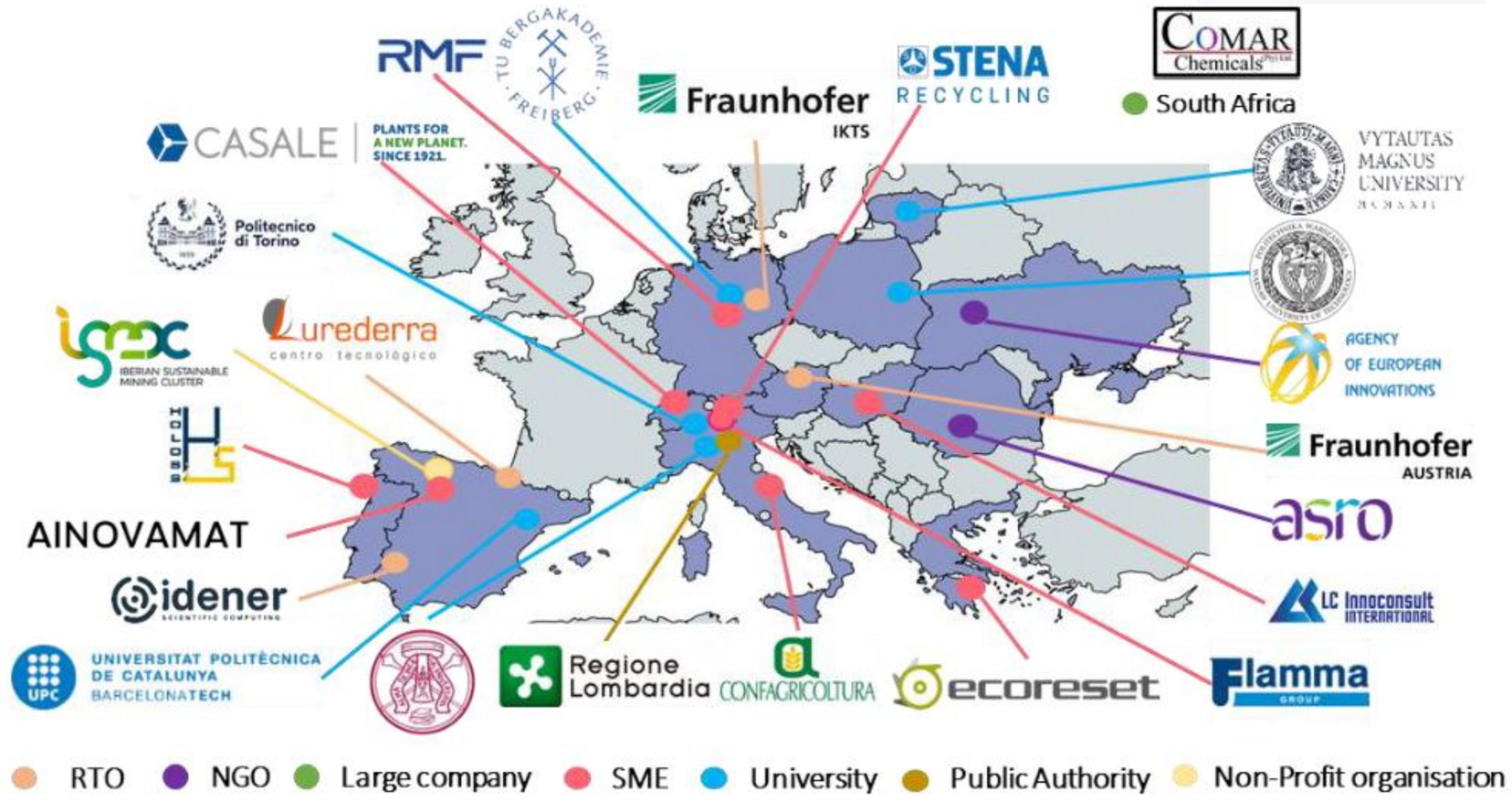

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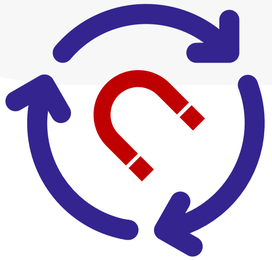
What is the project about?

The NEO-CYCLE project aims to demonstrate at TRL6 the sustainable upcycling of spent NdFeB magnets from hard disk drives (HDDs).

Reaching high-quality end products for 4 case studies:

- **pharmaceutical**
- **ammonia**
- **fertilisers**
- **polymer industries**



To reach this aim, NEO-CYCLE involves all the relevant actors in the value chain, from public authorities to WEEE recycler companies, technology developers, associations, NGOs, and commercial companies in the target sectors.

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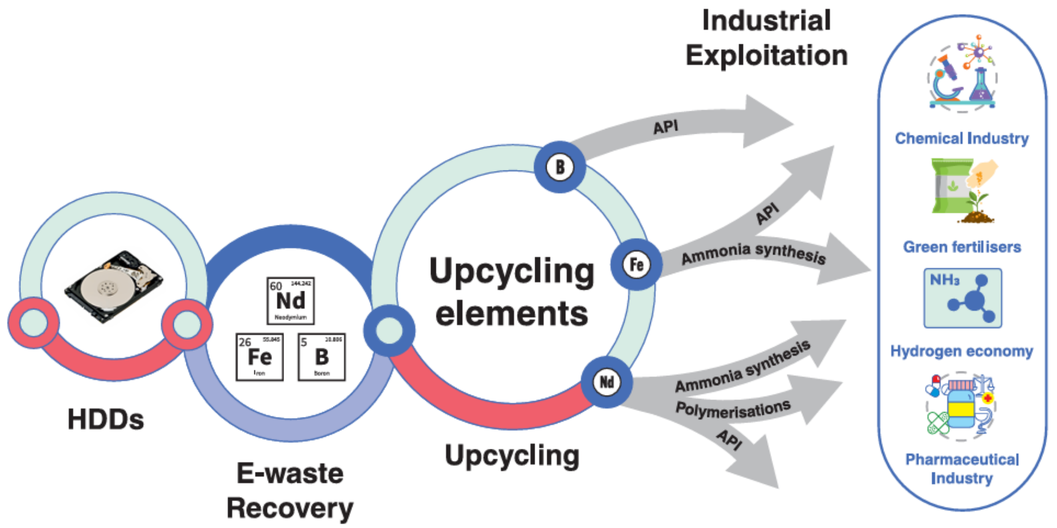
What is the project about?

Main objectives

1. **Demonstrating at TRL6 the technical feasibility of secondary NdFeB magnets upcycling.**
2. **Demonstrating circularity and sustainability of the NdFeB magnets upcycling concept.**
3. **Develop an upcycling process that can reach the market competitively, with socially accepted, inclusive and democratic business models, built in cooperation with all relevant stakeholders.**



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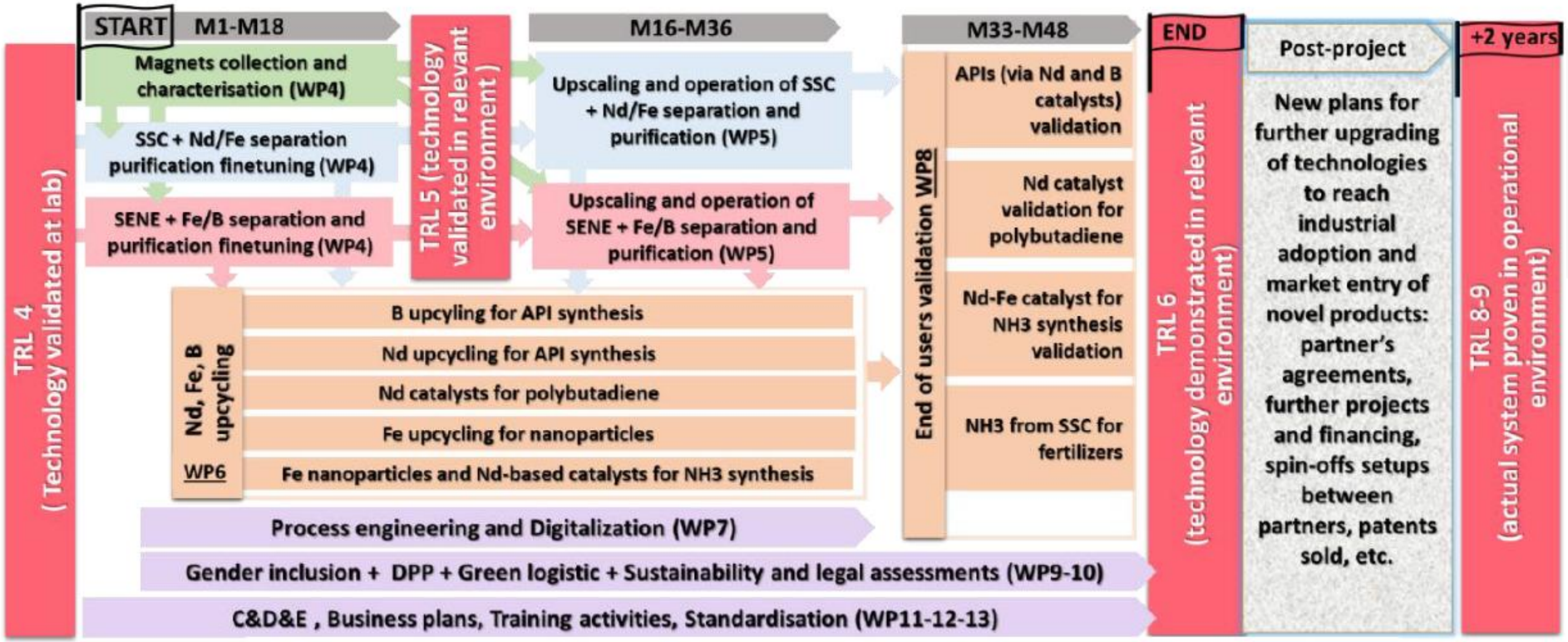

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What is the project about?

Main milestones

Project starts
September 2024

First samples of B, Fe and Nd obtained
August 2025

Protocols for upscaling to separately recover B, Fe and Nd
February 2026

Demonstration of upcycling approaches with recycled elements
June 2028

Sustainability assessments completed
August 2028

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What is the project about?

Main activities

1. Demonstration of a Solid-State Chlorination, Electrochemical and Purification processes at TRL6 to separate Nd, Fe and B reaching market needed purities.
2. Demonstration of Upcycling approaches of Nd, Fe, and B at TRL6 by developing industrial catalysts for the four case studies.
3. Validation of the quality and performance of final products by leading commercial companies.
4. Including processes and products digitalisation: mathematical modelling and optimisation, monitoring and digital twins of plants, and digital product passports.
5. Sustainability assessments to demonstrate the techno-economic and social viability of solutions, including a guide to consider the gender dimension in the different project stages.
6. Paving the way to market by *e.g.*, assessments of current legislation and future development, creating new business models and performing a standardisation roadmap.

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What is the project about?

Main expected results

1. **Optimised Solid-State Chlorination (SSC) and Selective Electrochemical Neodymium Extraction (SENE) methodologies.**
2. **B-based products for API synthesis (B-based drugs).**
3. **Nd-based catalytic systems in different industrial sectors:**
   - **API such as Corey lactone synthesis,**
   - **polymerisation (butadiene).**
4. **Fe-based catalytic systems**
   - **green ammonia synthesis,**
   - **API.**
5. **Fe-Nd-based catalytic systems for ammonia synthesis.**

WP6

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WP6 - Upcycling of Nd, Fe and B

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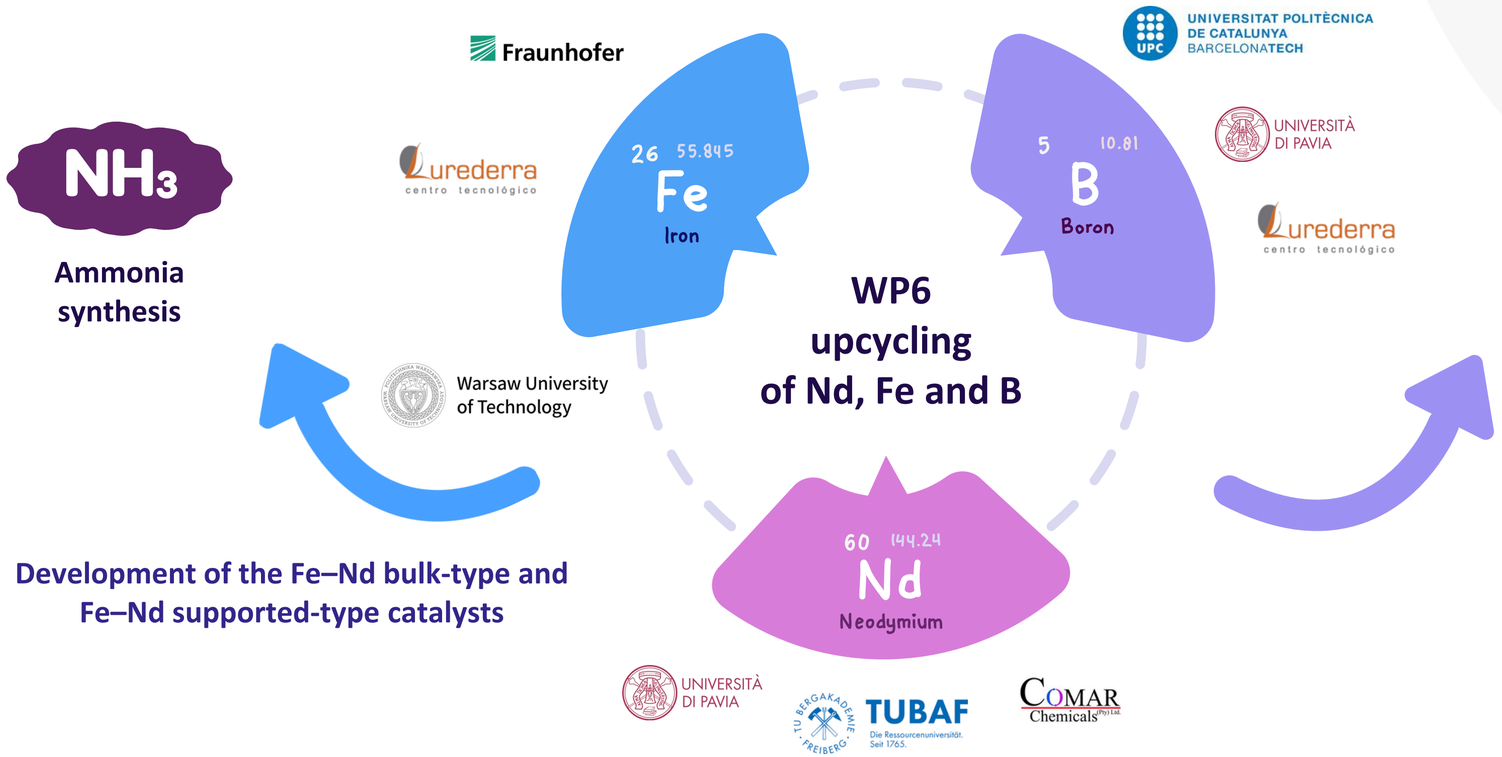
WP6 - Upcycling of Nd, Fe and B



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WP6 - Objectives

Preparation of isopropyl alcohol B ester and Bis(pinacolato)diboron to validate the Suzuki C-C coupling using upcycled B.

Production of Fe and Nd-based catalysts to be used in API and polymerisation reactions.

Development and upscaling of the Fe-Nd catalysts for ammonia synthesis and decomposition.

RELATIONS WITH OTHER WPs
WP4: Inventory and finetuning of Nd, Fe and B recovery
WP5: Upscaling to separately recover Nd, Fe and B
WP8: Quality and performance validation by market
WP9: Sustainability assessments
WP10: Regulatory considerations

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Catalysts for ammonia synthesis (WUT)

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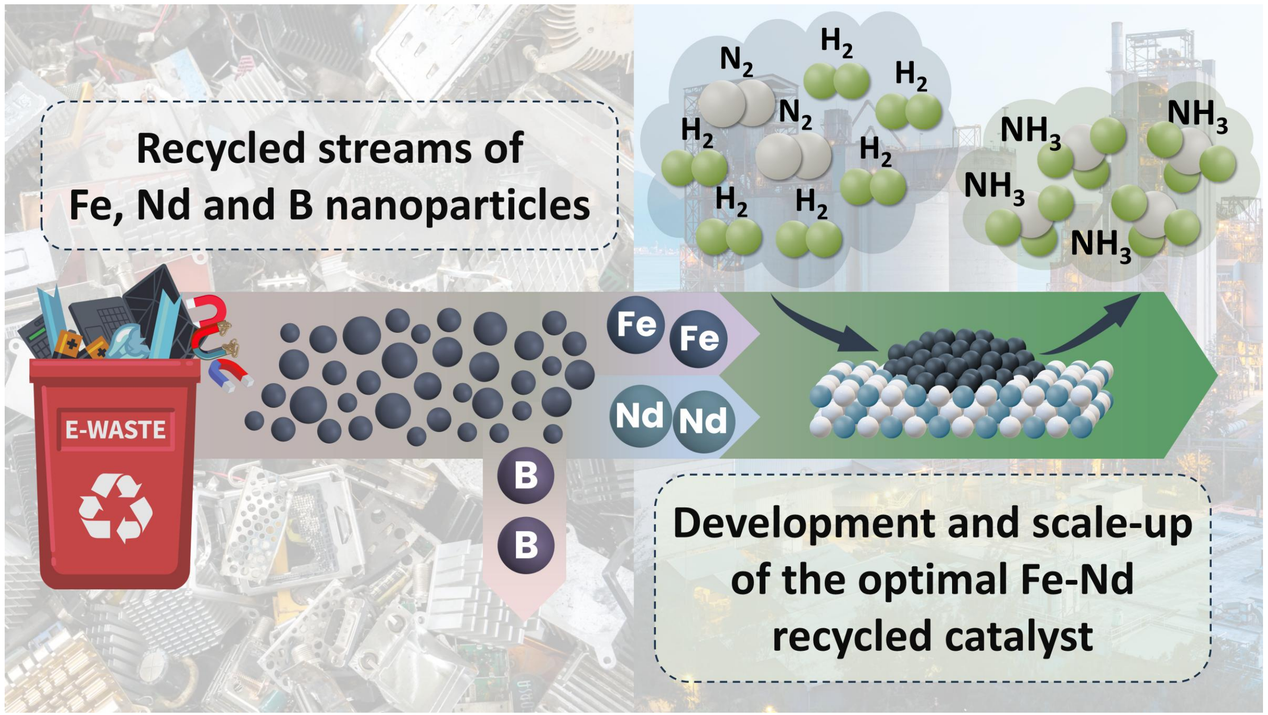
What is WUT working on in NEO-CYCLE?



Development of the Fe–Nd bulk-type and Fe–Nd supported-type catalysts

- Development of Fe-Nd inverse catalysts through the co-precipitation method.
- Synthesis of Nd_2O_3-based supported catalysts using Fe as an active phase.

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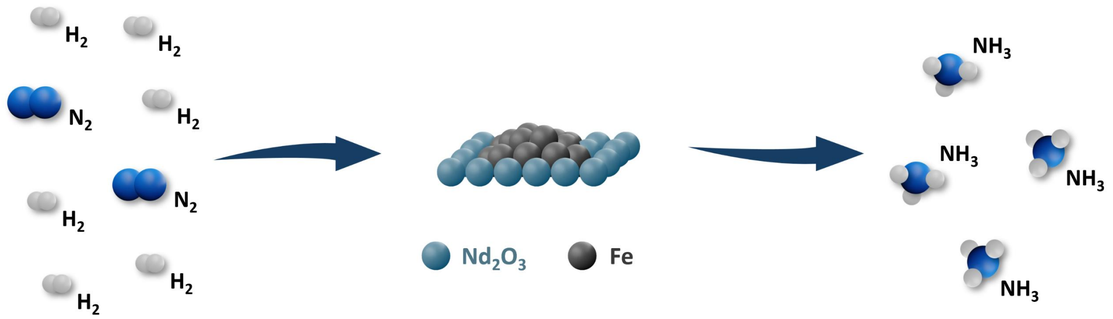
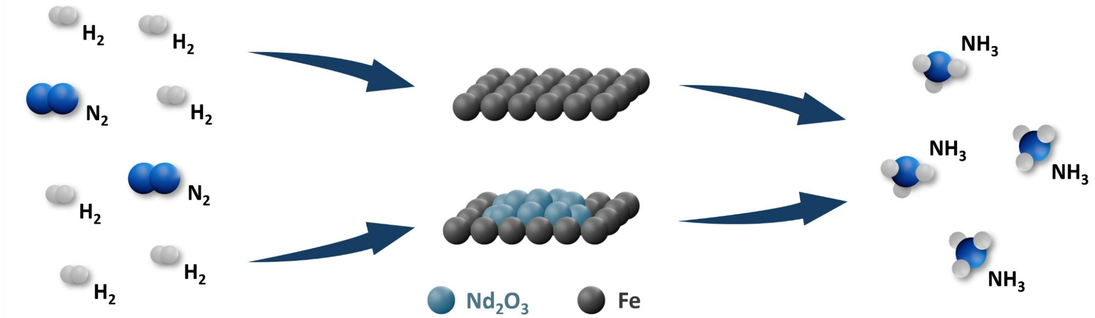
Fe–Nd catalysts for ammonia synthesis and decomposition

Supported catalysts: Fe/Nd_2O_3



Inverse catalysts: Nd_2O_3/Fe



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Preliminary results: monometallic supported catalysts

Conducted study on Nd_2O_3-supported Fe, Co, and Ni monometallic catalysts.

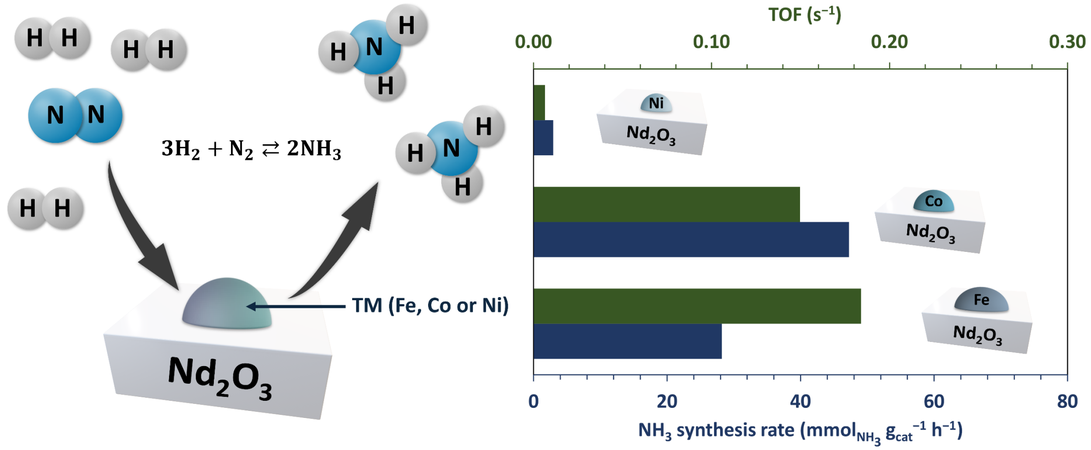
Findings:

- ❑ **Co/Nd_2O_3** → Highest ammonia formation rate.
- ❑ **Fe/Nd_2O_3** → Highest intrinsic reaction rate (TOF value).
- ❑ **Ni/Nd_2O_3** → Minimal catalytic activity.

Identified sintering issues with Fe nanoparticles – further optimisation of the synthesis procedure or composition is needed.

Strategies for optimisation:

- ❑ Alloying Fe and Co.
- ❑ Modifying the synthesis procedure.
- ❑ Introducing additives/promoters.



Catalysis Today 461 (2026) 115535
DOI: 10.1016/j.cattod.2025.115535

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What is next?

Further optimisation studies of catalysts:

- ❑ various methods of synthesis,
- ❑ addition of promoters,
- ❑ synthesis of a catalyst with salts from e-waste.

After getting the final catalyst:

- ❑ kinetic measurements in different conditions (temperatures, pressures, feed gas composition),
- ❑ cooperation with an industrial partner, **CASALE** – testing, modelling and designing a reactor with the resulting catalyst.

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JOIN OUR STAKEHOLDER ECOSYSTEM TO TAKE PART OF NEO-CYCLE' EVENTS

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THANK YOU FOR YOUR ATTENTION!

Hubert Ronduda
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