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## Plan Overview

*A Data Management Plan created using DMPonline*

**Title:** REEcycle - An environmental-friendly alternative to recovery Rare Earth Elements from spent NdFeB permanent magnets by electrochemical recycling process

**Creator:** Camila Pucci Couto

**Principal Investigator:** Camila Pucci Couto

**Data Manager:** Camila Pucci Couto

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**Funder:** European Commission

**Template:** Horizon Europe Template

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### Project abstract:

The European Union (EU) has the ambitious target to reach net zero greenhouse gas emissions by 2050. The current energy transition is playing a crucial role in achieving a greener future by electrification of industries and the use of renewable resources for energy. Many greener applications rely on electric motors or generators that contain NdFeB permanent magnets (PM) in large quantities. The composition of these magnets is about 30 % of rare-earth elements (REEs), mainly neodymium (Nd). The worldwide supply of REEs is controlled by China (85 %). As the demand of REEs is increasing, due to energy transition, it is important for the EU to ensure a continuous supply of REEs. Recycling end-of-life magnets is a feasible alternative to obtain REEs from secondary resources. With REEcycle research project, my objective is to determine, for the first time, the leaching mechanism of REEs in NdFeB magnet scrap, aiming at selective recovery of REEs by means of electrochemical leaching in organic acids. I will combine different electrochemical approaches at different scales to evaluate the electroleaching efficiency in organic acids aiming at the selection of the most suitable acid and process conditions for a high dissolution rate of REEs. Then, to determine the leaching mechanism under electrochemical effect, I will use a recently developed local electrochemical technique, scanning electrochemical cell microscopy (SECCM), which will indicate the dissolution parameters for each element present in the NdFeB matrix. Finally, with the findings from SECCM, I will be able to promote a controlled electroleaching in organic acid followed by oxidation of Fe<sup>2+</sup>, to selectively recover the REEs from the magnet scrap. With my project, the use of organic acids and an electrochemical approach will bring the realisation of a sustainable recycling of permanent magnets a step forward, thereby contributing to the EU's knowledge in REE supply from secondary sources.

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# **REEcycle - An environmental-friendly alternative to recovery Rare Earth Elements from spent NdFeB permanent magnets by electrochemical recycling process**

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## **Data Summary**

### **Will you re-use any existing data and what will you re-use it for?**

No, there is no data available that answers our research question.

### **What types and formats of data will the project generate or re-use?**

Whenever possible, we will use file formats suitable for long-term preservation and re-use of research data. From electrochemical measurements I expect to obtain data as \*.xlsx and \*.csv format; from SEM-EDS and EBSD I will obtain images as \*.jpg.

### **What is the purpose of the data generation or re-use and its relation to the objectives of the project?**

The purpose of data generation is related to the achievement of the main objective of the research project, which is to determine the leaching mechanism of REEs in NdFeB magnet scrap for a selective recovery of REEs by means of electrochemical leaching in organic acids.

### **What is the expected size of the data that you intend to generate or re-use?**

Less than 250 GB in terms of data volume.

### **What is the origin/provenance of the data, either generated or re-used?**

The data will be collected/generated via experiments by Camila Pucci Couto for the purpose of determining the leaching mechanism of REEs in NdFeB magnet scrap for a selective recovery of REEs by means of electrochemical leaching in organic acids. Data analysis will be done by Camila Pucci Couto. The steps taken for data collection, analysis and visualization will be documented in [Word, Excel, PowerPoint, Notepad].

Additionally, all data files will be named using the following elements in the file name:

- Date or date range of experiment: YYYYMMDD
- Descriptive file name
- Initials of the person who last modified the file
- Version number of file

## **To whom might your data be useful ('data utility'), outside your project?**

The data underlying the figures and conclusions in academic papers could be suitable for reuse for researchers in our field of critical raw materials, mainly related to alternative recycling processes.

## **FAIR data**

### **2.1. Making data findable, including provisions for metadata: Will data be identified by a persistent identifier?**

All data will be made openly available through 4TU.ResearchData, a trusted and certified data repository. Every dataset will be assigned a Digital Object Identifier (DOI), to make them citable and persistently available.

### **2.1. Making data findable, including provisions for metadata: Will rich metadata be provided to allow discovery? What metadata will be created? What disciplinary or general standards will be followed? In case metadata standards do not exist in your discipline, please outline what type of metadata will be created and how.**

All datasets will be accompanied by rich metadata, adhering to the DataCite Metadata Standard, to ensure that they are findable.

### **2.1. Making data findable, including provisions for metadata: Will search keywords be provided in the metadata to optimize the possibility for discovery and then potential re-use?**

All data (underlying the published papers) resulting from the project will be made openly available through 4TU.ResearchData. To further aid their discoverability, keywords describing the datasets will be added.

### **2.1. Making data findable, including provisions for metadata: Will metadata be offered in such a way that it can be harvested and indexed?**

All data (underlying the published papers) will be made openly available through 4TU.ResearchData which uses [schema.org](https://schema.org) metadata, meaning that all datasets are indexed in Google Dataset Search.

### **2.2. Making data accessible - Repository: Will the data be deposited in a trusted repository?**

All data (underlying the published papers) will be made openly available through 4TU.ResearchData, a trusted and certified data repository. It has a CoreTrustSeal certification.

**2.2. Making data accessible - Repository: Have you explored appropriate arrangements with the identified repository where your data will be deposited?**

We have prepared this Data Management Plan with the support of our Faculty Data Steward who works closely with the 4TU.ResearchData repository and has informed us about the policies and procedures of the 4TU.ResearchData repository. If needed, the Faculty Data Steward will refer us to professionals at 4TU.ResearchData to discuss appropriate arrangements.

**2.2. Making data accessible - Repository: Does the repository ensure that the data is assigned an identifier? Will the repository resolve the identifier to a digital object?**

All data (underlying the published papers) will be made openly available through 4TU.ResearchData, which is a trusted and certified data repository and assigns a Digital Object Identifier (DOI) to datasets and code to make them citable and persistently available.

**2.2. Making data accessible - Data:**

**Will all data be made openly available? If certain datasets cannot be shared (or need to be shared under restricted access conditions), explain why, clearly separating legal and contractual reasons from intentional restrictions. Note that in multi-beneficiary projects it is also possible for specific beneficiaries to keep their data closed if opening their data goes against their legitimate interests or other constraints as per the Grant Agreement.**

Yes, all datasets (underlying the published papers) will be made openly available through the 4TU.ResearchData.

**2.2. Making data accessible - Data:**

**If an embargo is applied to give time to publish or seek protection of the intellectual property (e.g. patents), specify why and how long this will apply, bearing in mind that research data should be made available as soon as possible.**

Not applicable.

**2.2. Making data accessible - Data:**

**Will the data be accessible through a free and standardized access protocol?**

4TU.ResearchData uses the HTTPS protocol (Hypertext Transfer Protocol Secure) which is based on TCP/IP.

## **2.2. Making data accessible - Data:**

**If there are restrictions on use, how will access be provided to the data, both during and after the end of the project?**

Not applicable. All data generated will be made openly.

## **2.2. Making data accessible - Data:**

**How will the identity of the person accessing the data be ascertained?**

Identity of individuals accessing the data on 4TU.ResearchData can only be established when restricted access is in place. Contributors can leave their contact details in the README file if they would like to be contacted when the dataset is reused.

## **2.2. Making data accessible - Data:**

**Is there a need for a data access committee (e.g. to evaluate/approve access requests to personal/sensitive data)?**

No, there is no need.

## **2.2. Making data accessible - Metadata:**

**Will metadata be made openly available and licenced under a public domain dedication CC0, as per the Grant Agreement? If not, please clarify why. Will metadata contain information to enable the user to access the data?**

Yes, it will. In 4TU.ResearchData, metadata may be freely reused under the CC0 waiver. Information about the accessibility of the dataset is also included in the metadata. Most datasets in 4TU.ResearchData are openly available, and can be accessed directly from the dataset's landing page. Datasets that are embargoed or restricted have a clear statement how access to the data files can be obtained.

## **2.2. Making data accessible - Metadata:**

**How long will the data remain available and findable? Will metadata be guaranteed to remain available after data is no longer available?**

TU Delft researchers can archive their research data using 4TU.ResearchData, which will archive and preserve the data for at least 15 years.

## **2.2. Making data accessible - Metadata:**

**Will documentation or reference about any software be needed to access or read the data be included? Will it be possible to include the relevant software (e.g. in open source code)?**

Not applicable.

### **2.3. Making data interoperable:**

**What data and metadata vocabularies, standards, formats or methodologies will you follow to make your data interoperable to allow data exchange and re-use within and across disciplines? Will you follow community-endorsed interoperability best practices? Which ones?**

No community-agreed metadata standards exist for this discipline. To ensure interoperability the data will be documented appropriately (README files etc.) to allow re-use and operability across disciplines. Additionally, the data underlying the publications will be available through [4TU.ResearchData](#) (which uses [DataCite metadata](#) schema and [Dublin Core](#)).

### **2.3. Making data interoperable:**

**In case it is unavoidable that you use uncommon or generate project specific ontologies or vocabularies, will you provide mappings to more commonly used ontologies? Will you openly publish the generated ontologies or vocabularies to allow reusing, refining or extending them?**

We will use common terminology used in the field to describe the data.

### **2.3. Making data interoperable:**

**Will your data include qualified references [\[1\]](#) to other data (e.g. other data from your project, or datasets from previous research)?**

**[\[1\]](#) A qualified reference is a cross-reference that explains its intent. For example, *X is regulator of Y* is a much more qualified reference than *X is associated with Y*, or *X see also Y*. The goal therefore is to create as many meaningful links as possible between (meta)data resources to enrich the contextual knowledge about the data. (Source: <https://www.go-fair.org/fair-principles/i3-metadata-include-qualified-references-metadata/>)**

To ensure interoperability the DOIs of research outputs should be linked whenever possible. For publications the DOIs and information about these research outputs can be listed in a 'Data Availability Statement' as well as cited in the reference list to allow tracking of citations. The DOI of the publication can be linked to the other research outputs in the metadata and the README file.

### **2.4. Increase data re-use:**

**How will you provide documentation needed to validate data analysis and facilitate data re-use (e.g. readme files with information on methodology, codebooks, data cleaning, analyses, variable definitions, units of measurement, etc.)?**

All documentation needed to validate data analysis and facilitate data re-use will accompany the data via a README file created in accordance with the 4TU.ResearchData guidelines.

#### **2.4. Increase data re-use:**

**Will your data be made freely available in the public domain to permit the widest re-use possible? Will your data be licensed using standard reuse licenses, in line with the obligations set out in the Grant Agreement?**

Yes, all data will be available in the public domain, in line with the obligations set out in the Grant Agreement.

#### **2.4. Increase data re-use:**

**Will the data produced in the project be useable by third parties, in particular after the end of the project?**

The data underlying the publications will be available at [4TU.ResearchData](#) under a CC-BY license, allowing third parties to use the data.

#### **2.4. Increase data re-use:**

**Will the provenance of the data be thoroughly documented using the appropriate standards?**

Yes, see section 2.3.

#### **2.4. Increase data re-use:**

**Describe all relevant data quality assurance processes.**

The data which will be generated during the research project will be compared with results from benchmarking procedures. For instance, electroleaching will be compared with chemical leaching (benchmarking).

#### **2.4. Increase data re-use:**

**Further to the FAIR principles, DMPs should also address research outputs other than data, and should carefully consider aspects related to the allocation of resources, data security and ethical aspects.**

See the answers to the following questions.

### **Other research outputs**

**In addition to the management of data, beneficiaries should also consider and plan for the management of other research outputs that may be generated or re-used throughout their projects. Such outputs can be either digital (e.g. software, workflows, protocols, models,**

**etc.) or physical (e.g. new materials, antibodies, reagents, samples, etc.).**

The management of other research outputs, such as physical samples, will be carefully planned. Samples will be kept in the lab storage of MPRR research group at TU Delft for at least 5 years.

**Beneficiaries should consider which of the questions pertaining to FAIR data above, can apply to the management of other research outputs, and should strive to provide sufficient detail on how their research outputs will be managed and shared, or made available for re-use, in line with the FAIR principles.**

FAIR principles will be followed pertaining to the management of all research outputs during the project.

## **Allocation of resources**

**What will the costs be for making data or other research outputs FAIR in your project (e.g. direct and indirect costs related to storage, archiving, re-use, security, etc.) ?**

Cost will be mostly to ensure open science.

**How will these be covered? Note that costs related to research data/output management are eligible as part of the Horizon Europe grant (if compliant with the Grant Agreement conditions)**

Cost will be covered by the funds from the Horizon Europe grant.

**Who will be responsible for data management in your project?**

The principal investigator, Camila Pucci Couto, will be the responsible for the data management.

**How will long term preservation be ensured? Discuss the necessary resources to accomplish this (costs and potential value, who decides and how, what data will be kept and for how long)?**

TU Delft researchers can archive their research data (up to 1TB per researcher per year) free of charge at 4TU.ResearchData.

4TU.ResearchData will take care of data archiving and preservation for at least 15 years.

## Data security

**What provisions are or will be in place for data security (including data recovery as well as secure storage/archiving and transfer of sensitive data)?**

During the project, data will storage data on SURFdrive and OneDrive.

After the end of the project, it can be considered to publish all datasets in [4TU.ResearchData](#). The data will be openly accessible to all.

## Ethics

**Are there, or could there be, any ethics or legal issues that can have an impact on data sharing? These can also be discussed in the context of the ethics review. If relevant, include references to ethics deliverables and ethics chapter in the Description of the Action (DoA).**

No, there are not.

**Will informed consent for data sharing and long term preservation be included in questionnaires dealing with personal data?**

No, there will be not.

## Other issues

**Do you, or will you, make use of other national/funder/sectorial/departmental procedures for data management? If yes, which ones (please list and briefly describe them)?**

We are going to be in compliance with the [TU Delft Research Data Framework Policy](#) stating that research data, code and any other materials needed to reproduce research findings are appropriately documented and shared in a research data repository in accordance with the FAIR principles (Findable, Accessible, Interoperable and Reusable) for at least 10 years from the end of the research project, unless there are valid reasons not to do so.