

NWE-SMARTX Guidebook

16 June 2023

Sophie Lejeune, Laurie Lommel

SPAQUE, ATRASOL

Version 1



SUMMARY

1	Introduction	2
1.1	The REMICRRAM Methodology	2
1.2	About this guidebook	3
2	The NWE-SMARTX tool	4
2.1	General description and back-end functioning.....	4
2.2	Home.....	4
2.3	Site.....	6
2.4	Input Data.....	7
2.5	Results.....	8
3	Modules.....	9
3.1	Geophysics.....	9
3.2	Excavation.....	11
3.3	Mineral.....	12
3.4	Metal	13
3.5	Ecocatalyst.....	13
4	Associated documents.....	15
4.1	template.....	15
4.2	Report	15
4.3	Inputs-Outputs	15
4.4	E-library documents.....	15
5	To go further.....	15
6	Annexes.....	16
6.1	Import and export files correspondence table	16
6.1.1	Geophysics correspondence table	16
6.1.2	Excavation correspondence table	17
6.1.3	Mineral correspondence table	17
6.1.4	Metal correspondence table.....	18
6.1.5	Ecocatalyst correspondence table	19

1 INTRODUCTION

With the decline of metallurgical and industrial activities and the progressive relocation of these activities outside Europe, many metallurgical sites and deposits have been left abandoned in North-West Europe (hereafter named “Post Metallurgical Sites and Deposits – PMSD). In 2013, the number of metallurgical sites with metal recovery potential was estimated at 100000 by JRC. Given that the European supply of metals and raw materials is at risk of being undermined, these past metallurgical site and deposits could be a new source to recover secondary raw materials.

The NWE-REGENERATIS project brought together researchers and stakeholders in the fields of geophysics, eco-catalysis, mineral and metal valorization, as well as artificial intelligence. This collaboration has led to the development of decision support tools proposing innovative approaches for the characterization and valorization of materials typically found in former metallurgical sites.

These tools are integrated into the REMICRRAM methodology (i.e. the NWE-REGENERATIS methodology) intend to provide a cost-effective and quick way to estimate the potential and methods for site valorisation.

The Smart Decision Support Tool NWE-SMARTX, which is the focus of this guidebook is the second step of the REMICRRAM methodology described here after. It was designed to help select the adapted processes for an optimized regeneration of Past Metallurgical Sites and Deposits (PMSD).

1.1 THE REMICRRAM METHODOLOGY

The NWE-REGENERATIS project has created a 3-step methodology named REMICRRAM to evaluate the site potential for material recovery. This process determines whether further investment is worthwhile, thus preventing unnecessary expenses when the site recovery potential is insufficient. The 3-step methodology involves using 3 tools, one at each step (see Fig. 1):

- Step 1: SMARTPHOENIX - a generic site selection (quick scan) tool
- Step 2: NWE-SMARTX - an AI-based technical and economical site and processes selection tool
- Step 3: Business cases software - a complete cost-benefit analysis tool that includes evaluating the economic, social and political impacts of a given project

The site's interest is determined based on 4 different types of materials:

- The metal recovery potential of a site
- The mineral recovery potential of a site
- The potential for improving soil fertility at a low cost to grow biomass, a.o. for ecocatalysis production
- The potential for ecocatalysts production at the site

REMICRRAM provides a quick and cost-effective estimation/quantification of a site's material recovery potential. This methodology 1) facilitates the selection and characterization of PMSD, 2) demonstrates the recovery potential of secondary raw materials from PMSD, and 3) enables the creation of site-specific plans using an AI tool called SMARTIX.

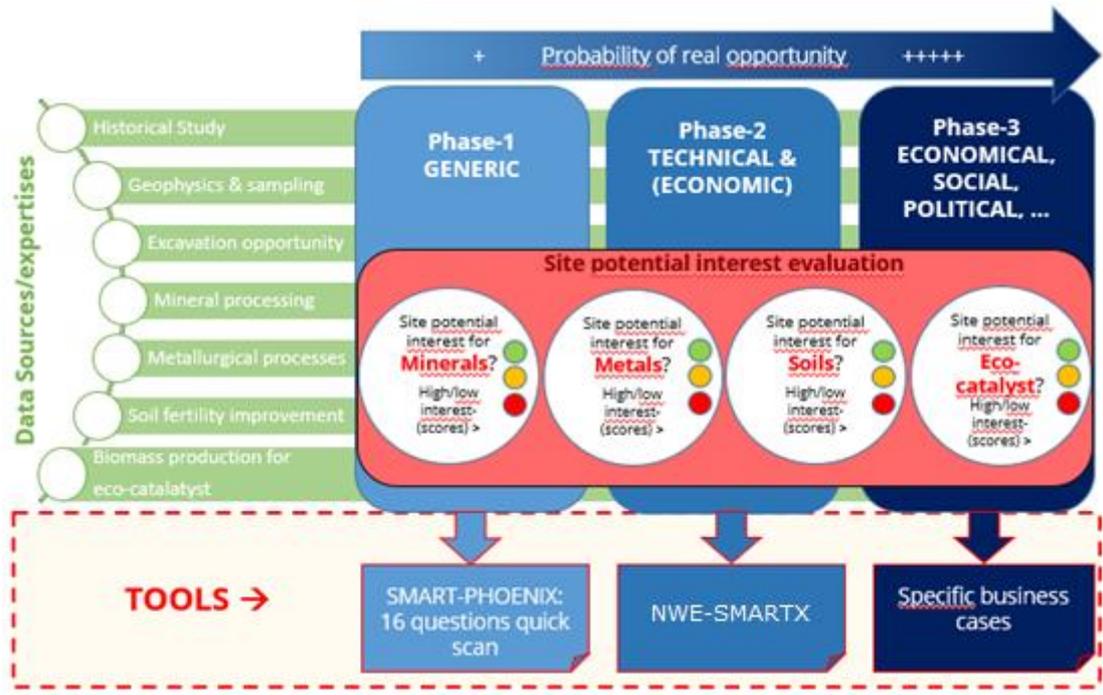


Figure 1: REMICRRAM general overview

1.2 ABOUT THIS GUIDEBOOK

This guidebook is the user-friendly manual for the NWE-SMARTX tool, which is part of the REMICRRAM methodology. It provides a detailed overview of the tool's structure, its back-end functioning, and a description of the data and fields that are included in the tool.

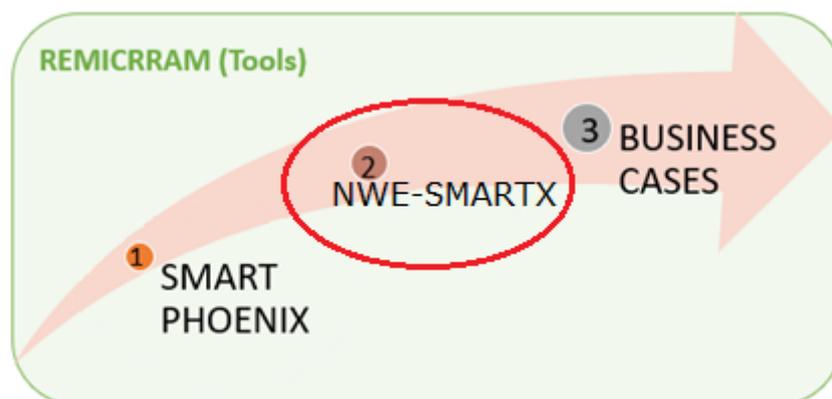


Figure 2: how this guidebook fits in the REMICRRAM methodology

2 THE NWE-SMARTX TOOL

2.1 GENERAL DESCRIPTION AND BACK-END FUNCTIONNING

The NWE-SMARTX is provided as an Open Source application based on artificial intelligence that runs locally on the end user computer. It has been trained through the collection of expert information. Its objective is to suggest innovative valorization paths for the materials present on site based on the site and material characteristics.

Five distinct predictive modules have been developed:

- **Geophysics**
- **Metals**
- **Minerals**
- **Excavation**
- **Eco-catalysis.**

These modules recommend to the user:

- Geophysical methods that can be applied to gain better knowledge of the volume and location of residues on the metallurgical sites (Geophysics),
- Civil engineering methods recommended to optimize the excavation and pre-treatment of materials (Excavation),
- Valorisation methods based on site characteristics, material volumes, and types of materials present on site (Mineral, Metal, Eco-catalyst).

To obtain the recommendations, the user enters data related to the past metallurgical site to be assessed. For data input, the information is sorted by module. It can be manually entered through the interface or imported using a provided Excel template. Once the data is entered, the user can access the results and recommendations, which are calculated using Python-based engines. The user can visualize them for each module individually or all at once. Additionally, an information bubble is available, providing an explanation to facilitate understanding.

The application was developed to run on Windows 10 and 11. As it is an Open Source Software, both the application and its source code are readily available.

More information on the development of the NWE-SMARTX can be found in specific reports available in the projects' [e-library](#).

The following sections develop the software various interfaces.

2.2 HOME

The '**HOME**' page opens when you double click on the software icon after installation:



The home menu (Figure 3) presents you with five areas:

- **Demo:** a Demo version of the NWE-SMARTX with prefilled data from a test site
- **NWE-SMARTX:** the computation software itself
- **Practical guide:** a link to the present guide
- **Template:** a link to download the excel version of the template
- **Video learning:** a link to the e-learning tool SMARTIX module



Figure 3 NWE-SMARTX HOME page

The NWE-REGENERATIS key visual will direct you to the project’s website and the SPAQuE logo to the SPAQuE website which also hosts the e-learning tool module of the project and the installer of the software.

By clicking on the NWE-SMARTX area, the **Site** page appears where you will be able to handle your site database.

2.3 SITE

The **Site** page visible in Figure 4 allows you to create, modify, import and export data from various sites. It also allows you to manage you site database.

To create a site, click on the **Add site**. An empty line appears. Click on the pen icon to modify the site data. You will be prompted to enter the various fields to identify your site. The fields marked with a red button are mandatory. Click **update** to create you new site.

Site datas can be exported individually or several at once under excel format. To select the sites to be exported, cross the check box in front of the site name.

Importing a site can be done by clicking on the **Import site** button and selecting an excel file resulting from the **Export site** button. These functionalities allow you to exchange site data between collaborators on various computers.

To select and begin working on a site, double click on it. You will be directed to the Input Data page.

A deposit name and number are required as the NWE-SMARTX is designed to provide results for materials of uniform characteristics which is thus labelled **deposit** in the software. If several types of material are present by deposit, meaning for uniform quantities of material, new entries should be entered under different deposit names.

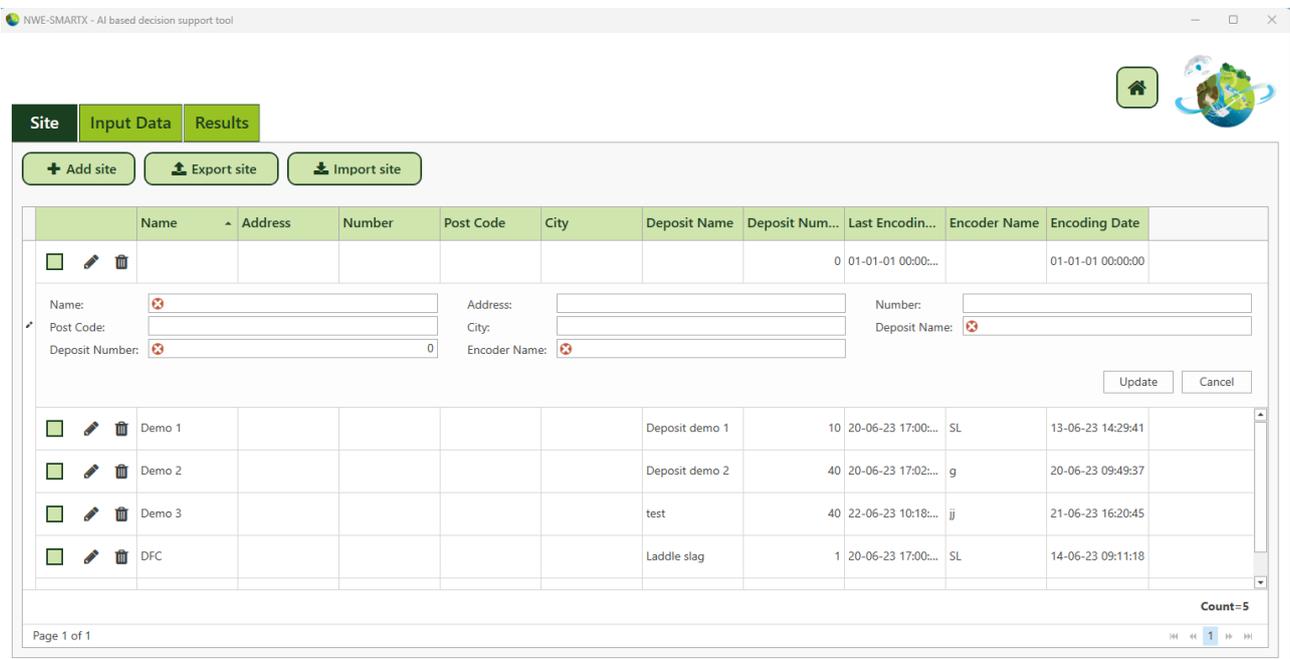


Figure 4 SITE page

2.4 INPUT DATA

The **Input Data** page is the area where you will be prompted to enter the data related to your site characteristics (Figure 5).

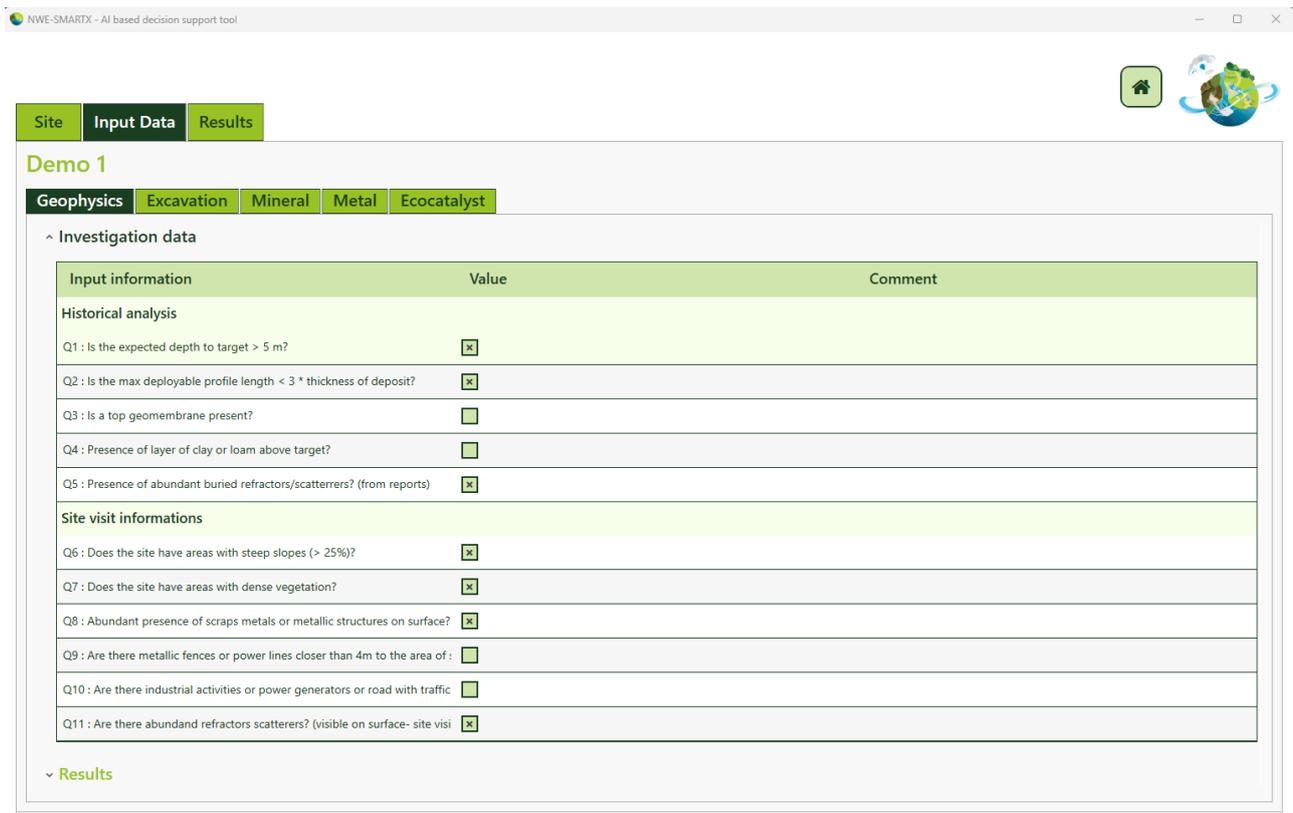
The name of the site you are working on is displayed for ease of use.

Below you will find the five subsections corresponding to the five modules (**Geophysics**, **Excavation**, **Mineral**, **Metal** and **Ecocatalyst**). Each module section will be detailed later in the present document.

By clicking on the module name, you will be able to see and fill the data required by each of them. They take the form of check boxes, drop down menus or fillable sections. Warnings will be prompted when the input values are out of admissible ranges.

The data to be filled are divided into **Investigation data** or **Laboratory data** subsections when applicable. A **Results** subsection is also present (Figure 5). The **Results** subsection is at first empty.

To compute the results, you will need to go under the Results main page next to the Input Data page.



The screenshot shows a web browser window titled "NWE-SMARTX - AI based decision support tool". The interface includes a navigation bar with "Site", "Input Data", and "Results" tabs. Below this, a "Demo 1" header is followed by five module tabs: "Geophysics", "Excavation", "Mineral", "Metal", and "Ecocatalyst". The "Investigation data" section is expanded, showing a table with three columns: "Input information", "Value", and "Comment".

Input information	Value	Comment
Historical analysis		
Q1 : Is the expected depth to target > 5 m?	<input checked="" type="checkbox"/>	
Q2 : Is the max deployable profile length < 3 * thickness of deposit?	<input checked="" type="checkbox"/>	
Q3 : Is a top geomembrane present?	<input type="checkbox"/>	
Q4 : Presence of layer of clay or loam above target?	<input type="checkbox"/>	
Q5 : Presence of abundant buried refractors/scatterers? (from reports)	<input checked="" type="checkbox"/>	
Site visit informations		
Q6 : Does the site have areas with steep slopes (> 25%)?	<input checked="" type="checkbox"/>	
Q7 : Does the site have areas with dense vegetation?	<input checked="" type="checkbox"/>	
Q8 : Abundant presence of scraps metals or metallic structures on surface?	<input checked="" type="checkbox"/>	
Q9 : Are there metallic fences or power lines closer than 4m to the area of :	<input type="checkbox"/>	
Q10 : Are there industrial activities or power generators or road with traffic	<input type="checkbox"/>	
Q11 : Are there abundand refractors scatterers? (visible on surface- site visi	<input checked="" type="checkbox"/>	

Below the table, a "Results" section is visible but currently empty.

Figure 5 Input Data page

2.5 RESULTS

Once you have filled the Input Data pages, you can go to the Results page. At first, the Results page is empty (Figure 6). Click on the **Calculate results** button to generate the results. Results will appear and the **Generate report** button will become available (Figure 7).

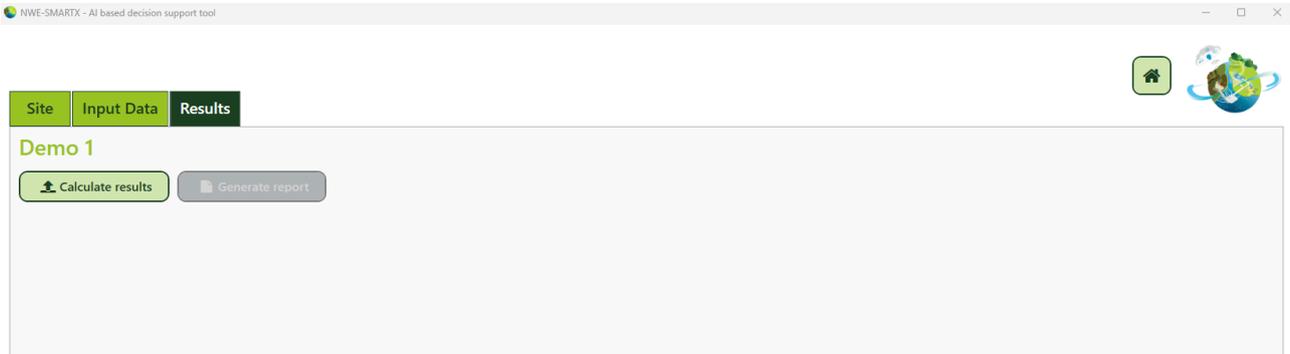


Figure 6 Results page when creating a new site

Once the results have been generated, they will appear on the **Results** page for all modules, but they will also be available in the **Input Data -> Results** sections, for each module, individually.

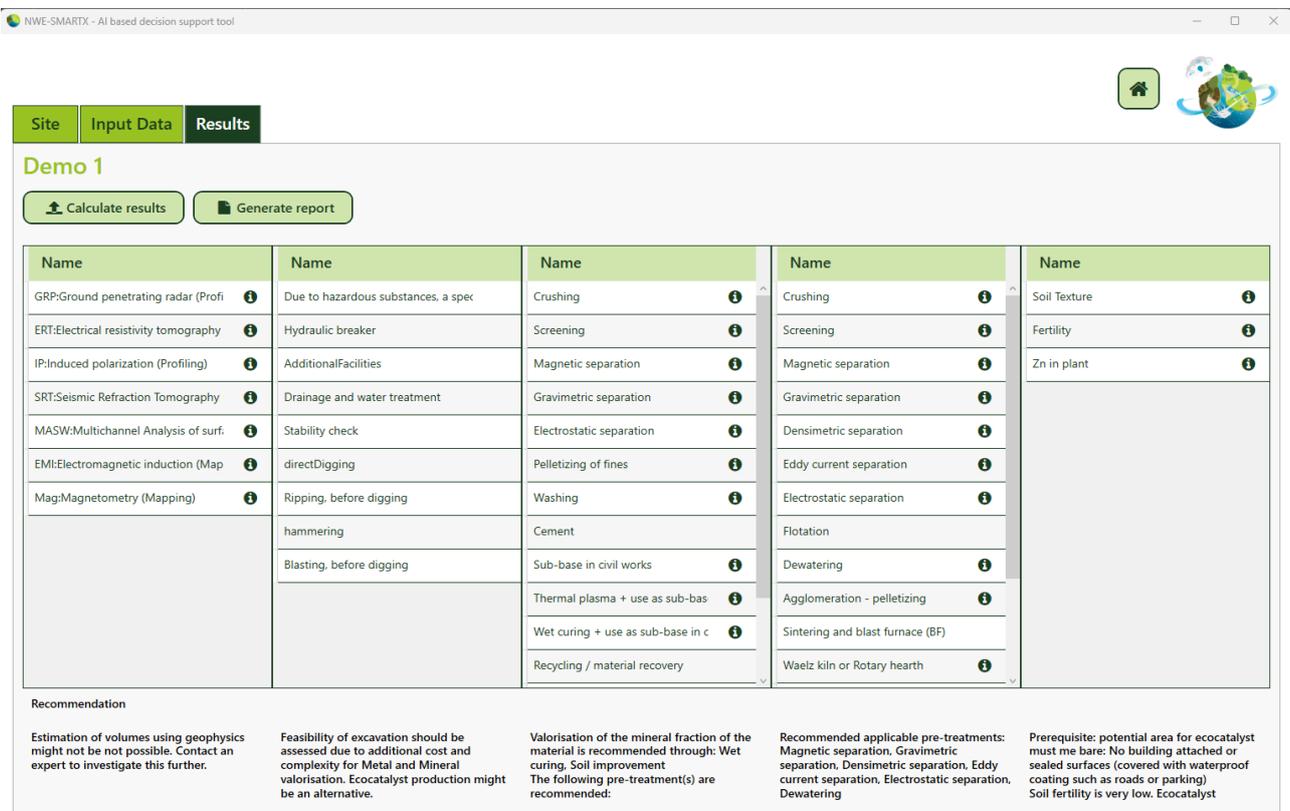


Figure 7 Results page after calculating the results

The content of the results is specific to each module and will be detailed below. An additional information button is presented next to each result when applicable. A general recommendation for each module is also available below each section.

The **Generate report** button exports both input datas and results for all modules in an excel file format which corresponds to the template that is downloadable on the home page.

The results of each module aim at providing technical guidance for the characterization and valorisation processes. The economic viability of the recommendations is meant to be evaluated in the next step of the REMICRRAM methodology, the Business case.

3 MODULES

Five modules are available in the present tool to help build a valorisation project for the material present on site. The modules are designed to either help characterize the site and material quality (Geophysics), provide information on pre-requisite actions to excavate and handle the material (Excavation) or give technical recommendation on valorisation options.

Each module follows the same structure for ease of use with the data divided based on their origin, investigation data (which correspond to historical or site visit information) or laboratory analysis, followed by the results. Their content is detailed in the subsections below.

The results are at first empty and their computation need to be prompted by going on the **'Calculate results'** button on the **Results** page.

3.1 GEOPHYSICS

The geophysics module is designed to help identify the best applicable geophysical methods for site investigation based on the site characteristics.

Geophysics is a powerful tool for non to low invasive investigation of the volume and quality of material available which are input parameters of other modules. Geophysics can also in some cases, provide indication on the quality of the material and help design a targeted sampling plan. Geophysics use is usually cheaper and faster than traditional investigation techniques. Its use however depends on the configuration of the site.

To identify the best applicable methods, the user is prompted to answer eleven questions which serve as inputs in this module. These questions deal with site configuration and information that should be available based on historical or site visit collected data. Their list is visible in Figure 8. To answer 'Yes', simply tick the box, leave it unchecked for 'No'.

Geophysics		
Excavation	Mineral	Metal
Ecocatalyst		
^ Investigation data		
Input information	Value	Comment
Historical analysis		
Q1 : Is the expected depth to target > 5 m?	<input checked="" type="checkbox"/>	
Q2 : Is the max deployable profile length <	<input checked="" type="checkbox"/>	
Q3 : Is a top geomembrane present?	<input type="checkbox"/>	
Q4 : Presence of layer of clay or loam above	<input type="checkbox"/>	
Q5 : Presence of abundant buried refractors	<input checked="" type="checkbox"/>	
Site visit informations		
Q6 : Does the site have areas with steep slope	<input checked="" type="checkbox"/>	
Q7 : Does the site have areas with dense vegetation	<input checked="" type="checkbox"/>	
Q8 : Abundant presence of scraps metals or	<input checked="" type="checkbox"/>	
Q9 : Are there metallic fences or power lines	<input type="checkbox"/>	
Q10 : Are there industrial activities or power	<input type="checkbox"/>	
Q11 : Are there abundant refractors scattered	<input checked="" type="checkbox"/>	

Figure 8 Geophysics module Investigation data

The outputs of the modules are the seven geophysical methods that were tested as application for past metallurgical site investigation throughout the project, associated with a percentage.

An interpretation table of the results with a color code is present on the right side of the panel. It is based on the relevance of the result to apply geophysics to obtain information and a global recommendation as well as additional relevant information are listed in the **Recommendation** panel below.

Additional information on each method can be obtained by hovering over the 'information' logo next to each method.

Geophysics
Excavation
Mineral
Metal
Ecocatalyst

∨ Investigation data

∧ Results

Methods	Value		Value	Interpretation
GRP:Ground penetrating radar (Profiling)	0%	i	0 %	Non informative
ERT:Electrical resistivity tomography (Profiling)	80%	i	25%	Low interest
IP:Induced polarization (Profiling)	80%	i	50%	Qualitative interest
SRT:Seismic Refraction Tomography (Profiling)	5%	i	75%	Quantitative interest
MASW:Multichannel Analysis of surface wave (Profiling)	12%	i	100%	Material estimation
EMI:Electromagnetic induction (Mapping)	11%	i		
Mag:Magnetometry (Mapping)	22%	i		

Recommendation

Estimation of volumes using geophysics should be possible using the following methods : ERT, IP.
 Warning ! The use of ERT or IP will require to pierce the geomembrane if present. Possibility to do so and budget to repair it should be considered.

Figure 9 Geophysics module - Results

3.2 EXCAVATION

The excavation module deals with identification of civil engineering methods and preliminary processes to put in place to proceed to the excavation of the identified materials.

All inputs are investigation data. They have been implemented as tick boxes as in the geophysics module or as drop-down lists to facilitate the encoding process. They concern information relative to the site configuration such as the position of the water table, the presence of slopes, the type of soil or the presence of hazardous material. More detailed information on the inputs can be obtained either by clicking on the 'Help pdf' button, by hovering over the information logo.

The various answers will then prompt the user to take into consideration various measures that will be listed in the Results section. Each necessary measure will then add relative cost and complexity to the project final design identified in the respective columns. Depending on the added costs and complexity of the overall results, the user will then be invited to take these

parameters into account in the cost-benefit analysis or to turn to alternative valorisation options such as eco-catalyst if excavation generates prohibitive costs to the project.

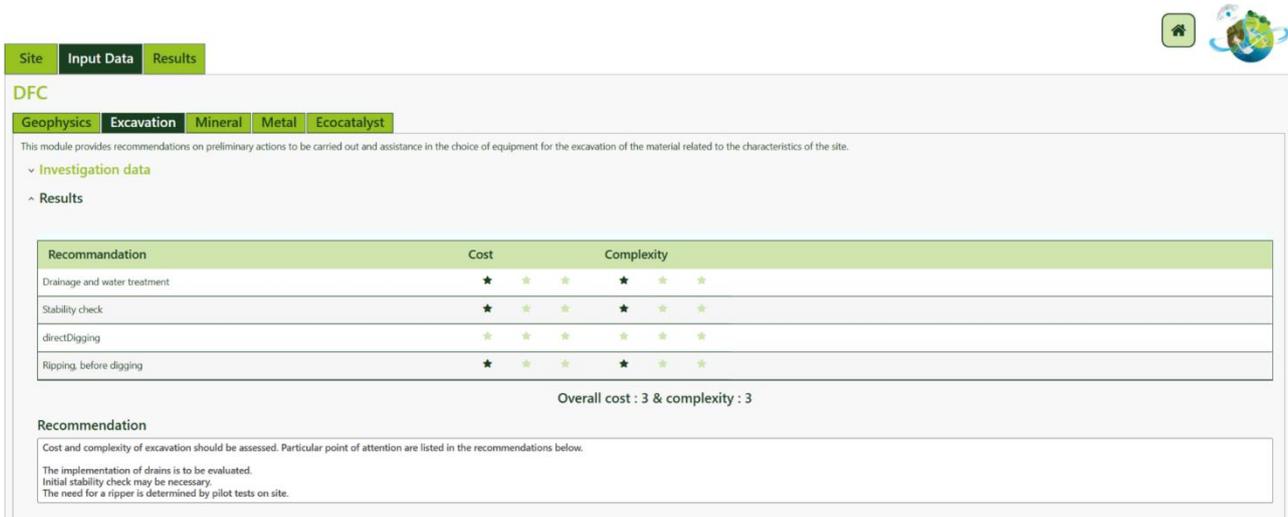


Figure 10 Excavation results

3.3 MINERAL

The mineral module identifies possible mineral recovery technologies and preprocessing treatments based on both investigation data and laboratory analysis information.

Some input parameters such as accessibility and approximative tonnage define the global feasibility or impact the cost of the whole process while the other input parameters are related to specific process feasibility.

The metal and mineral modules use similar input parameters thus a ‘Sync’ button has been added for ease of use. Note however that not all parameters are common.

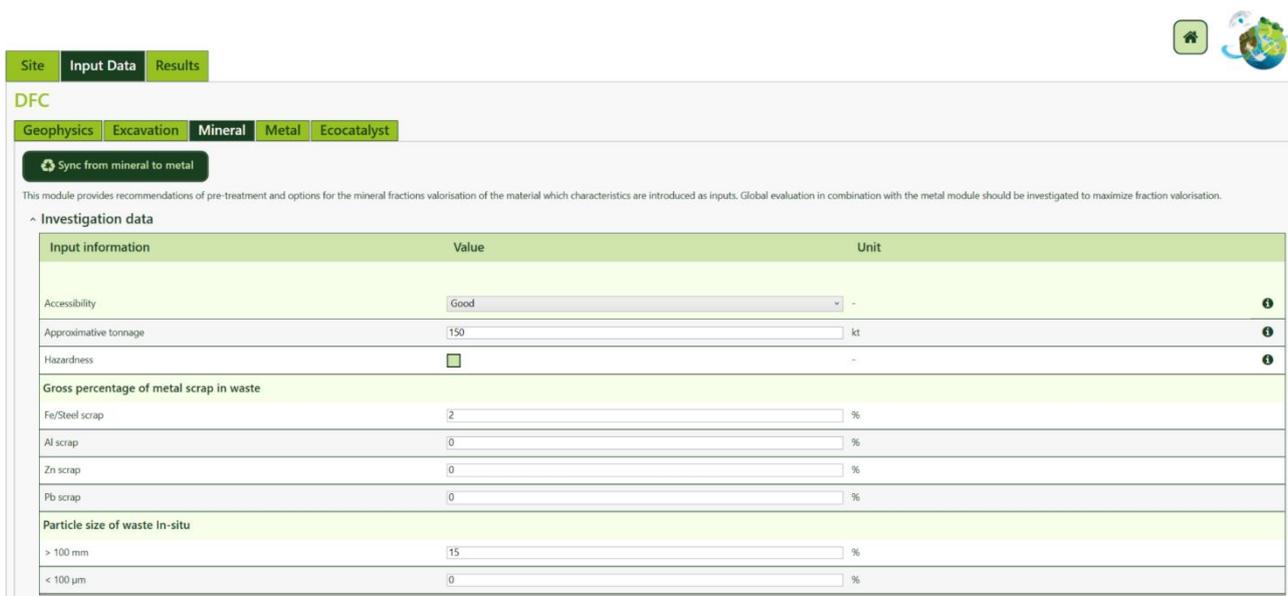
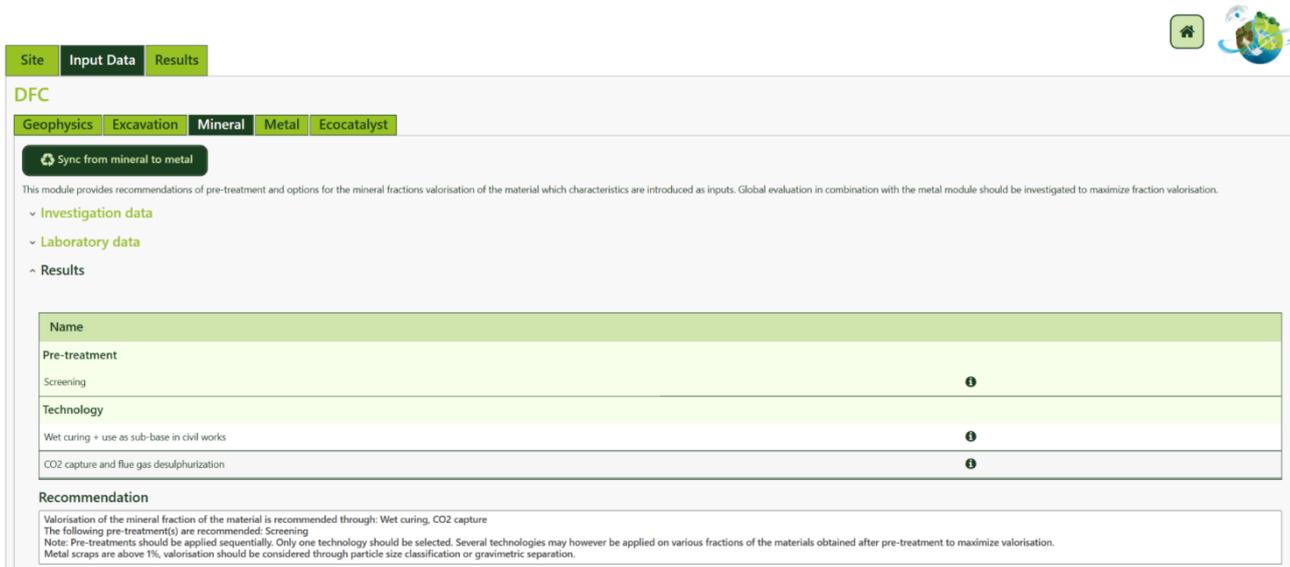


Figure 11 Mineral Investigation data results

In this module, most parameters need to be encoded as numbers, either in the Investigation data or in the Laboratory data section.



The screenshot shows the 'Mineral' results section of the DFC interface. It includes a 'Sync from mineral to metal' button, a description of the module's purpose, and a table of recommended pre-treatments and technologies. A 'Recommendation' box at the bottom provides additional context.

Name	
Pre-treatment	
Screening	1
Technology	
Wet curing + use as sub-base in civil works	1
CO2 capture and flue gas desulphurization	1

Recommendation
 Valorisation of the mineral fraction of the material is recommended through: Wet curing, CO2 capture
 The following pre-treatment(s) are recommended: Screening
 Note: Pre-treatments should be applied sequentially. Only one technology should be selected. Several technologies may however be applied on various fractions of the materials obtained after pre-treatment to maximize valorisation.
 Metal scraps are above 1%, valorisation should be considered through particle size classification or gravimetric separation.

Figure 12 Mineral Results

Results take the form of recommended pre-treatments and technologies. A comment has been added to each output to help identify each technology's final use of the material.

3.4 METAL

The metal module identifies metal extraction processes and preprocessing treatments based on both investigation data and laboratory analysis information. The input data for this module is similar to the information used in the mineral module. These modules are usually interconnected as a fraction of the material can sometimes be valorized in metal recovery and the rest through the mineral recovery routes.

As in the mineral module, some input parameters such as hazardness and approximative tonnage define the global feasibility or impact the cost of the whole process while the other input parameters are related to specific process feasibility.

As in the mineral module, comments have been added to some outputs to help identify each technology's finality.

3.5 ECOCATALYST

In ecocatalysis, metallic elements in accumulator/tolerant plants are recovered and transformed into eco-friendly plant-based catalysts. Ecocatalysis process has two advantages: soil remediation by using accumulating plants and the reuse of metals extracted by the plants.

The ecocatalyst module is designed to help assess the fertility of the soil and its potential for the production of a Zinc based ecocatalyst as an alternative valorisation route to metal and mineral recovery.

The Ecocatalyst inputs are Investigation data such as the area of bare land and the site accessibility as well as soil analysis data. Information of the norm and process to collect these data can be found in the help PDF and by hovering the mouse over the 'information' icon in regard to the input value. The zinc concentration in the soil is a mandatory field for this module. Other parameters may not be entered, the accuracy of the results might however be affected. A warning message will be displayed in such cases.

Outputs are the soil texture that will influence the soil fertility, the soil fertility itself and the Zn content to be expected in the plant.

During the project, a focus was made on the production of zinc based ecocatalysis but the production based on other elements is possible and should not be neglected.

Site **Input Data** Results

DFC

Geophysics **Excavation** Mineral Metal **Ecocatalyst**

In ecocatalysis, metallic elements in accumulator/tolerant plants are recovered and transformed into eco-friendly plant-based catalysts. Ecocatalysis process has two advantages: soil remediation by using accumulating plants and the reuse of metals extracted by the plants. Use this module to assess the potential for ecocatalyst on your site.

~ Laboratory data

InputName	Value	Unit
Inventory		
Available bareland area	5	ha
Area easily accessible with machines	<input checked="" type="checkbox"/>	-
Laboratory analyses		
Soil contamination : Zn content (required)	3738.6	mg/kg
Sand fraction (granulometry)	10	%
Silt fraction (granulometry)	10	%
Clay fraction (granulometry)	80	%
Soil pH	8.09	-
Cation exchange capacity	0	cmol+/kg
CaCO ₃	123.6	g/kg
Available phosphorus	0.81	g/kg
Corg / Ntot	0	-
Electrical conductivity	0	Ms/cm

Site **Input Data** Results

DFC

Geophysics **Excavation** Mineral Metal **Ecocatalyst**

In ecocatalysis, metallic elements in accumulator/tolerant plants are recovered and transformed into eco-friendly plant-based catalysts. Ecocatalysis process has two advantages: soil remediation by using accumulating plants and the reuse of metals extracted by the plants. Use this module to assess the potential for ecocatalyst on your site.

~ Laboratory data

~ Results

Name	Value
Soil Texture	Optimal
Fertility	Medium
Zn in plant	161,01mg/kg

Recommendation

Prerequisite: potential area for ecocatalyst must be bare: No building attached or sealed surfaces (covered with waterproof coating such as roads or parking).
Soil fertility is very low. Ecocatalyst production might not be feasible or require important amendment of the soil. The cost should be integrated in the business model.

4 ASSOCIATED DOCUMENTS

4.1 TEMPLATE

A template in the form of an excel spreadsheet can be downloaded from the **Home** page of the tool. It contains a summary of all inputs and results data of the NWE-SMARTX. It has been designed to allow another mean of visualizing the data. This also shows the full inputs and outputs list of the tools.

For the template to remain compatible with the tool for import, no modifications to lines disposition or columns or in the names of the inputs can be made. Only the fields values can be entered.

4.2 REPORT

The **Generate report** button will export both the input data and the results in a single excel spreadsheet that can then be easily manipulated.

4.3 INPUTS-OUTPUTS

The Site page will export data of a site for exchange or backup of the data in a reduced format consisting solely of a reduced name and corresponding value of the site information. The document is protected to ensure compatibility with the application. This protection can be removed to manipulate the data if required but the user accepts thus that compatibility might not be preserved with the application and that the data will thus not be compatible anymore with the information present in the application. For the file to remain compatible, no alteration to the name of the variables or to the line and columns disposition can be done.

The user must be careful to use the ‘,’ for decimal separation and not the ‘.’.

As the input names are reduced and the values in computing compatible form, a correspondence table has been provided in annex for the user information.

4.4 E-LIBRARY DOCUMENTS

Throughout the project, several documents have been developed, explaining the present tool development process, performance of algorithms and calibration procedure. These documents can be found in the e-library. Research using the keyword NWE-SMARTX will help you find them.

5 TO GO FURTHER

The NWE-SMARTX is a tool that was developed using both decision trees and artificial intelligence using data available at the time of the project between 2020 and 2023. It was trained on the data from both the project sites and from the literature. As the project is open source, the source code will be made available on GitHub.

The recommendations of the tool are designed to be included in a cost-benefit analysis for the third step of the REMICRRAM methodology which is the Business Case. Note that the recommendations have been designed using the project site datasets as well as literature data for the training of the artificial intelligence model. Accuracy of the results may thus be affected if the amount of data available is too low or if the input data deviate too much from the ones used in the training datasets. Information on the training methods can be found in the performance reports available in the e-library. Expert knowledge should thus still intervene and confirm results and feasibility of the projects and lab test are recommended to verify the feasibility of the recovery prior to launching large scale operations.

The artificial intelligence modules can be enhanced and retrained using other databases. A guide on the calibration of the NWE-SMARTX is available on the project website as well as the innovative database structure developed during the project.

Expert knowledge can be sought on the Open Access Platform developed to help various stakeholders of remediation of Past Metallurgical Sites get in touch with one another to launch recovery projects. The platform is accessible at the following address (until 2026): [REGENERATIS - Open Access Platform \(nwe-regeneratis.eu\)](https://www.nwe-regeneratis.eu).

6 ANNEXES

6.1 IMPORT AND EXPORT FILES CORRESPONDENCE TABLE

The tables below show the correspondence between the displayed values in the interface and the variables names in the export file as well as the corresponding numerical.

6.1.1 Geophysics correspondence table

Name	Displayed name	Corresponding values
Q1	Q1: Is the expected depth to target > 5m?	Yes = 1/no = 0
Q2	Q2: Is the max deployable profile length < 3 * thickness of deposit?	Yes = 1/no = 0
Q3	Q3: Is a top geomembrane present?	Yes = 1/no = 0
Q4	Q4: Presence of layer of clay or loam above target?	Yes = 1/no = 0
Q5	Q5: Presence of abundant buried refractors/scatterers? (from reports)	Yes = 1/no = 0
Q6	Q6: Does the site have areas with steep slopes (> 25%)?	Yes = 1/no = 0
Q7	Q7: Does the site have areas with dense vegetation?	Yes = 1/no = 0
Q8	Q8: Abundant presence of scraps metals or metallic structures on surface?	Yes = 1/no = 0
Q9	Q9: Are there metallic fences or power lines closer than 4m to the area of study	Yes = 1/no = 0
Q10	Q10: Are there industrial activities or power generators or road with traffic closer than 10m to the area of study?	Yes = 1/no = 0

Q11	Q11: Are there abundant refractors scatterers? (visible on surface- site visit)	Yes = 1/no = 0
------------	---	----------------

6.1.2 Excavation correspondence table

Name in input	Displayed name	Corresponding values
hazardous	Presence of hazardous waste (radioactive, asbestos,...)	1 = yes/0=no
exogenousLess5	Estimated proportion of large and hard exogenous material in the deposit	1 = <5%/0 = > 5%
gaz	Gaz content	1 = yes/0=no
slope	Steep slope (>15°)	1 = yes/0=no
waterTable	Water table position	[1 = volume is submerged by the water table by >5m; 2 = volume is fairly submerged by the water table (between 1 and 5m) ; 3 = volume is at least 1m above the water table = 3]
homogeneity	Estimated homogeneity of the material	[Homogenous = 1; Heterogenous = 0]
soilType	Type of soil	[1 = Rock masses; 2 = Gravel; 3 = Soil]
ISRangeOver3	IS Range (rock masses only)	[>3MPa = 1; <3Mpa = 0] + soilType ==3
gsiRange	GSI range (rock masses only)	[1-4 see table below] soilType ==3 + ISTangeOver3
hardMatOver50	Proportion of hard material (only for heterogenous material)	[>50% hard material = 1;<50% hard material = 0] + homogeneity = 0
osha	Soil type (according to Osha standards)	[1 = A; 2 = B; 3 = C; 4 = Rock]
bulkDensity	Bulk density >2T/m ³	1 = yes/0=no

GSI range when IS50<3MPa		GSI range when IS50≥3MPa	
<35	1	<30	1
35-55	2	30-50	2
55-70	3	50-60	3
>70	4	>60	4

6.1.3 Mineral correspondence table

Name	Displayed name	Corresponding values
Accessibility	Accessibility	1 = Good, 0 = Bad
Tonnage	Approximative tonnage	1 = Yes, 0 = No
Hazardness	Hazardness	

Steel	Fe/Steel scrap	
Al	Al scrap	
Znscrap	Zn scrap	
Pbscrap	Pb scrap	
size	> 100 mm	
microsize	< 100 µm	
Fe	Fe grade	
FeMetal	Fe° (metal) grade	
Zngrade	Zn grade	
Pb	Pb grade	
C	C grade	
S	S grade	
Cu	Cu grade	
Al2O3	Al2O3 grade	
CaO	CaO grade	
FreeLime	Free lime grade	
SiO2	SiO ₂ +Al ₂ O ₃ +Fe ₂ O ₃ grade	
MgO	MgO grade	
Cr2O3	Cr ₂ O ₃ grade	
ZrO	ZrO grade	
Cl	Cl grade	

6.1.4 Metal correspondence table

Name	Displayed name	Corresponding values
tonnage	Approximative tonnage	
hazardness	Hazardness	Yes/No
Steel	Fe/Steel scrap	
Al	Al scrap	
Znscrap	Zn scrap	
Pbscrap	Pb scrap	
size	> 100 mm	
microsize	< 100 µm	
Fe	Fe grade	
FeMetal	Fe° (metal) grade	
Zngrade	Zn grade	
Cgrade	C grade	
S	S grade	
Cu	Cu grade	
Al2O3	Al2O3 grade	
CaO	CaO grade	
SiO2	SiO ₂ +Al ₂ O ₃ +Fe ₂ O ₃ grade	
MgO	MgO grade	

Cr2O3	Cr ₂ O ₃ grade	
ZrO	ZrO grade	
Cl	Cl grade	

6.1.5 Ecocatalyst correspondence table

Name	Displayed name	Corresponding value (if applicable)
surface	Available bareland area	
accessibility	Area easily accessible with machines	Yes = 1, 0 = No
Zn content	Soil contamination : Zn content	
sand fraction	Sand fraction (granulometry)	
silt fraction	Silt fraction (granulometry)	
clay fraction	Clay fraction (granulometry)	
pHsoil	Soil pH	
CationExchange	Cation exchange capacity	
CaCO3	CaCO ₃	
phosphorus	Available phosphorus	
CorgNtot	C _{org} / N _{tot}	
ElecCond	Electrical conductivity	