

# GreenDealz



SHOP FOR THE FUTURE

## The VECTOR Public Engagement Toolkit User Manual

# Background Information

[The VECTOR project](#) seeks to identify ‘human-centered’ solutions to the resource issues facing the EU in attempting to achieve the EU Green Deal. The EU Green Deal is the legislation which sets out EU decarbonization targets. It has two key components: 1. A 55% reduction in green house gases within the EU by 2030 and 2. a carbon neutral EU by 2050.

To achieve these targets we need more **critical** raw materials (CRMs) to build the technologies for decarbonization such as solar PV, wind turbines, heat pumps, electric vehicles and much more. These are materials and metals that have been defined by the EU as ‘critical’ primarily due to their supply risk yet high economic and societal importance. Supply risk is generally represented by an over reliance on countries outside of the EU to extract and process these CRMs. Therefore, to achieve the EU Green Deal it is necessary to have a stable and low risk supply of CRMs, which poses the question of increased mining and exploration in Europe. The EU aims to have at least 10% of it’s annual CRM consumption extracted within Europe by 2030. The VECTOR project was created to understand the social, environmental and technical challenges that this creates.

“[GreenDealz](#)” is an interactive activity that aims to engage adults with the concept of CRMs and the EU Green Deal in an informal way. It is a ‘shopping’ activity, where players are asked to “shop” for a solar panel and a wind turbine from a selection of CRMs (represented by cubes on a periodic table/supermarket aisle).

Changes in knowledge can be evaluated via pre-post activity embedded assessment tasks. Therefore, the activity and its assessment tasks act as a CRM public engagement toolkit. This activity is designed to stimulate conversation and spark engagement between scientists and the public at informal settings (e.g., festivals) and to gain insight into public knowledge. We are not there to influence thoughts, opinions or actions but merely to engage.

GreenDealz has also been developed into an online game for more self-paced learning, [check out the vector project website to play!](#)

## Shorter explainer (use with participants)

GreenDealz is a hands-on public engagement toolkit developed as part of the VECTOR EU project, which explores Critical Raw Materials and the EU Green Deal.

GreenDealz invites participants to engage with this topic through “shopping” for the Critical Raw Materials needed to build renewable energies, with short interactive tasks integrated before and after shopping. Overall, GreenDealz is designed to prompt conversation, understand audience knowledge and enhance reflection about raw materials and the energy transition.

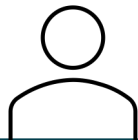
# GreenDealz Exhibit Map

## GreenDealz

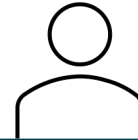


SHOP FOR THE FUTURE

Activity leaders



Table



### 2 GreenDealz shopping



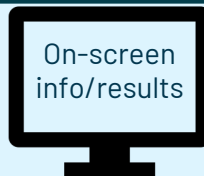
1  
+  
3

### Embedded Assessment

x3 guessing tasks to assess knowledge

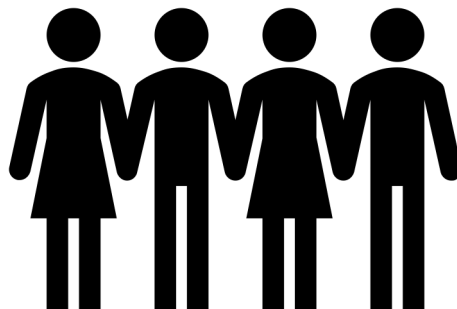


On-screen  
info/results



Data  
collection  
sheet:  
'shopping list'

Space for hand-  
samples or other  
CRM items



Participants

Group (max 4) or single

# Kit set-up: what do you need?

## **General materials and items**

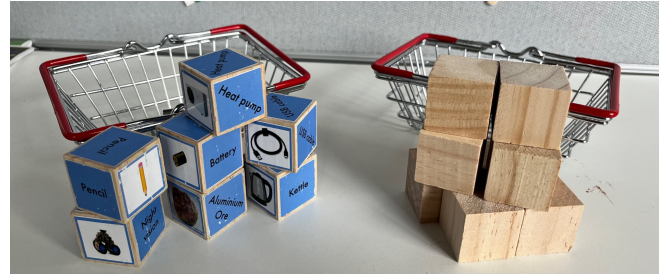
- 'Shopping list' data recording sheet (see appendix 1) & pens.
- Table for exhibit.
- GreenDealz results presentation slides ([available online](#)).
- Computer monitor/laptop.

**Set-up:** lay out 'shopping list', download presentation & display it on screen.

## **1 + 3 Embedded assessment**

- 16 wooden cubes (3 cm<sup>3</sup>): 9 plain and 7 used for blue stickers.
- Blue stickers (editable template [online](#) – all chosen items must contain CRMs for assessment purposes).
- 2 mini shopping baskets.
- Spare cubes.

**Set-up:** stick blue stickers to cubes as per appendix 2, lay out cubes and baskets as per picture 1.

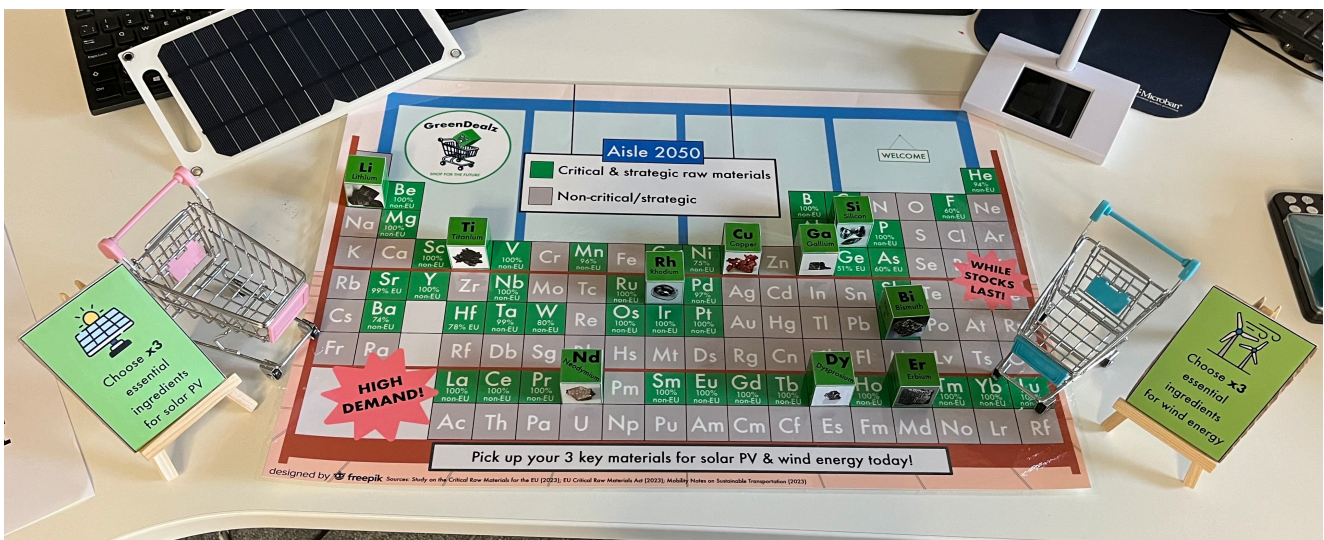


Picture 1.

## **2 GreenDealz Shopping**

- Green CRM stickers (editable CRM sticker templates are [online](#) - change to any of your choice but must be arranged so that only three available CRMs are key functional CRMs per technology to keep engagement within 15 minutes).
- 10 wooden cubes (3 cm<sup>3</sup>) covered by green CRM stickers (see appendix 3 for orientation).
- 2 mini shopping trolleys.
- GreenDealz A2 'supermarket aisle 2050' print – green boxes are CRMs and grey boxes are not CRMs (editable template [online](#) - update import reliance values if necessary).
- 2 mini easels and corresponding A7 signs.

**Set-up:** display green cubes on corresponding squares on supermarket aisle, display each A7 sign & easel next to a trolley either side of supermarket aisle (see picture 2).



Picture 2.

# Instructions: how does it work?

## 1 Embedded Assessment (Pre-'Shopping')

### Activity Leader General Instructions

- Welcome participants & explain toolkit briefly (use short explainer on page 2).
- Record participant ID (i.e., 'customer') on shopping list (e.g., picture 3).
- Flick through on-screen slides for each task below & encourage quick fire answers.

Customer	PRE-SHOPPING		
	Task 1	Task 2	Task 3
1	4	-2	28
2	3	-5	42

Picture 3.

**Do not provide any leading information - tell participants it's a guess & that they will be asked again.**

### Tasks (show on screen to participants)

**Allocated time for completion: 3 minutes**

#### **TASK 1)** "Place any thing(s) you think contain critical raw materials in the shopping basket."

- **Participant(s):** must choose a number of cubes to place in the shopping basket from the 7 blue cubes which each represent an object or material (picture 1 & appendix 2).
- **Activity leader:** record the number of cubes placed in the basket (between 0 and 7) under 'pre-shopping task 1' cell on the shopping list (e.g., picture 3).

#### **TASK 2)** "Compared to a gas-fired power plant, how many times **less OR more** mineral resources are needed (on average) for an onshore wind farm to make the same amount of energy? Place cubes in the shopping basket to illustrate."

- **Participant(s):** must choose a number of cubes to place in the shopping basket from the available 9 plain cubes (picture 1), then must indicate if their answer is – or + that number of cubes.
- **Activity leader:** record the chosen number of cubes and whether – or + (i.e., between -9 to +9) on 'pre-shopping task 2' cell on the shopping list (e.g., picture 3).

#### **TASK 3)** "Of the 49 EU critical (and strategic) raw materials, how many have an import reliance greater than 75%? Choose a number between 0 and 49."

- **Participant(s):** must choose a number between 0-49 as a guess.
- **Activity leader:** record chosen number in 'pre-shopping task 3' cell on shopping list (e.g., picture 3).

## 3 Embedded Assessment (Post-'Shopping')

- After GreenDealz shopping is complete (detailed on following page), repeat above tasks with participant(s) & record answers in shopping list (e.g., picture 4).
- Reveal embedded assessment correct task answers (appendix 4) via last few slides.

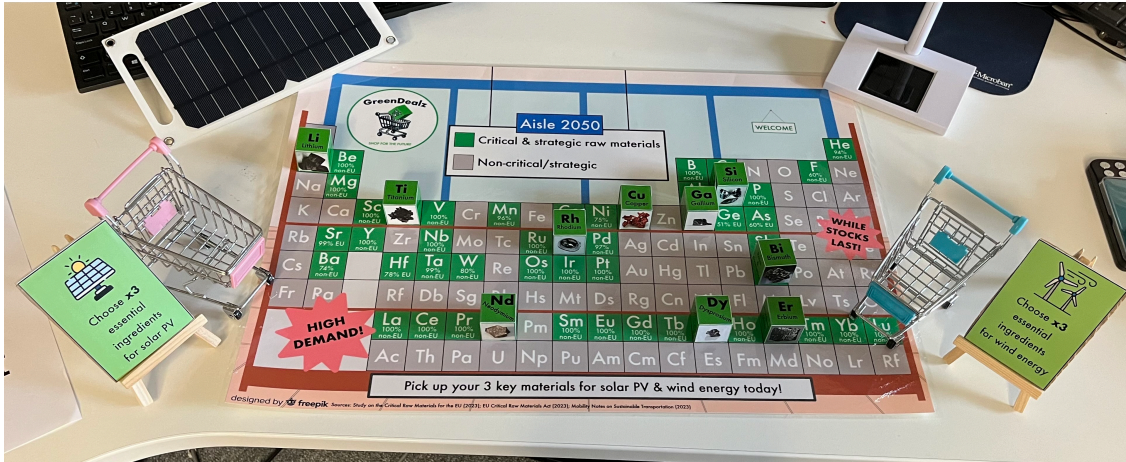
POST-SHOPPING		
Task 1	Task 2	Task 3
6	4	34
5	2	45

Picture 4.

# Instructions: how does it work?

2

## GreenDealz Shopping: which materials are needed for solar PV and for a wind turbine?



**Overview:** On the supermarket 'aisle 2050' there are green and grey squares. Green squares indicate CRMs and grey are not CRMs. There are 10 CRMs 'in-stock', i.e., the green cubes. Three are key FUNCTIONAL 'ingredients' for solar PV and another three are key FUNCTIONAL 'ingredients' for wind (see appendix 4). Participants must choose three key CRMs for each by placing them in the solar PV shopping trolley and subsequently in the wind turbine shopping trolley. Each CRM cube has prompts to help guide them (appendix 3).

### Activity Leader Guide & Script (steps progress on-screen)

Blue bold = key learnings during shopping

Pink = participant(s) action

#### Part 1: Introduce the GreenDealz Supermarket 'Aisle 2050'

- "Welcome to Aisle 2050 at the GreenDealz supermarket"
- "These green squares represent CRMs - they are many of the materials that make up the periodic table"
- "Only some CRMs are 'in-stock', you can see the **pure metals on the front and their ores/mined material on the back of cubes**"
- "You may recognise some of them, they are called critical raw materials because they are **important for many different technologies and everyday products/services**"

#### Part 2: Begin shopping

- "From the available stock please shop for **3 key CRMs** needed for solar PV using the clues on the cubes" – **participant browses cubes & loads up solar PV trolley.**
- "Thank you, now shop for a wind turbine and **note that you can take stock from your solar PV trolley if you think its needed**" – **participant browses cubes again (including any in solar PV trolley) & loads up wind trolley.**
- **IMPORTANT (time saver):** record chosen solar CRMs while they shop for wind, then record wind CRMs (e.g., appendix 1 & 4).

#### Part 3: Answer reveal

- Reveal answers to both technologies on slides – encourage where correct or close
- **Draw attention to shared CRMs (Copper) & thus mention supply & demand issues are part of what make a raw material critical**

#### Part 4: Education section

- Introduce **EU Green Deal** on next slide
- Follow up with slide on **CRM demand** (30 Gallium cubes demonstrate demand for solar PV 2050 targets)
- **Draw attention to import reliance % for Gallium and to all CRMs on Aisle 2050** – thus introduce the concept of increasing domestic supply for climate targets (consult import reliance key in appendix 5 if needed).

**Allocated time for completion: 9 minutes**

## Appendix 1: GreenDealz Shopping List

This is a data recording sheet used to track participant(s) answers. Blank sheets are [available online](#).

'G' indicates answers from a **group** of participants

[illegible]

Populate downwards for each new customer(s)

See appendix 4 for scoring details.







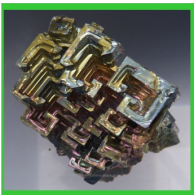



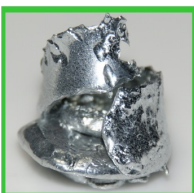

## Appendix 2: Reference for blue embedded assessment cubes

Each square represents a cube face

Face orientation >	Side	Front	Top	Back	Side
Cube 1 >		Aluminium Ore	Aluminium Ore	Aluminium Ore	
Cube 2 >		Battery	Battery	Battery	
Cube 3 >		USB cable	USB cable	USB cable	
Cube 4 >		Heat pump	Heat pump	Heat pump	
Cube 5 >		Kettle	Kettle	Kettle	
Cube 6 >		Pencil	Pencil	Pencil	
Cube 7 >		Night vision	Night vision	Night vision	



















# Appendix 3: Reference for green CRM shopping cubes

Each square represents a cube face

Face orientation >	Top	Front	Side	Side	Back
Face information >	CRM	Image (Pure)	Prompt (use or property)	Prompt (use or property)	Image (Common ore)
Cube 1 >	<b>Li</b> Lithium		Batteries	Ceramics	Lithium salts 
Cube 2 >	<b>Ti</b> Titanium		Aerospace	Industrial equipment	Rutile 
Cube 3 >	<b>Rh</b> Rhodium		Reduces exhaust emissions	Weather resistant	Chalcopyrite 
Cube 4 >	<b>Bi</b> Bismuth		Low melting alloys	Paint & cosmetics	Galena 
Cube 5 >	<b>Er</b> Erbium		Fibre optics	Infrared glass	Monazite 
Cube 6 >	<b>Ga</b> Gallium		LED lights	Partially conducts electricity	Bauxite 

# Appendix 3: Reference for green CRM shopping cubes

Each square represents a cube face

Face orientation >	Top	Front	Side	Side	Back
Face information >	CRM	Image (Pure)	Prompt (use or property)	Prompt (use or property)	Image (Common ore)
Cube 7 >	<b>Cu</b> Copper		Electrical wiring	Weather resistant	Chalcopyrite 
Barcodes > (cube base)	 Cu	 Nd	 Dy	 Si	 Li
Cube 8 >	<b>Nd</b> Neodymium		Super magnets	Spinning magnets = electricity	Monazite 
Cube 9 >	<b>Dy</b> Dysprosium		Maintains magnetic abilities	Infrared technology	Monazite 
Barcodes > (cube base)	 Ti	 Rh	 Bi	 Er	 Ga
Cube 10 >	<b>Si</b> Silicon		Partially conducts electricity	Helps turn light to electricity	Quartz 

Barcodes can be stuck to the base of each CRM cube if automated data collection via barcode scanning is desired.

## Appendix 4: Correct Answers & Scoring

### 1 + 3 Embedded assessment scores

**TASK 1) Place any thing(s) you think contain critical raw materials in the shopping basket.**

**Correct answer: 7** (i.e., all 7 cubes)

**Explainer:** all the objects/materials on the cubes contain one or more critical raw materials – they are everywhere!

**TASK 2) Compared to a gas-fired power plant, how many times less OR more mineral resources are needed (on average) for an onshore wind farm to make the same amount of energy? Place cubes in the shopping basket to illustrate.**

**Correct answer: 9 times more** (i.e., +9 cubes)

**Explainer:** On average, 9 times more mineral resources are needed to operate an onshore windfarm compared to a gas-fired power plant producing the same amount of energy.

**TASK 3) Of the 49 EU critical (and strategic) raw materials, how many have an import reliance greater than 75%? Choose a number between 0 and 49.**

**Correct answer & explainer: 37 are >75% reliant on imports**, but as import reliance % can change year on year, the highest possible score of **49 indicates the best knowledge of supply risk**.

**Embedded assessment evaluation:** To compare **pre to post change in audience knowledge** calculate the total score as a ratio via sum of scores/max possible score, where max possible score = 7 + 9 + 49.

### 2 GreenDealz shopping scores

Shopping scores help identify player interaction with the shopping activity, as CRM prompts have varying levels of difficulty, with easy prompts being more leading and harder prompts requiring greater reflection. Maximum score possible is 9 between both technologies (i.e., 4.5 + 4.5, see below).

Difficulty:		Easy (1 point)	Medium (1.5 points)	Hard (2 points)
<b>Solar PV:</b>	Correct CRMs:	<b>Silicon (Si)</b>	<b>Copper (Cu)</b>	<b>Gallium (Ga)</b>
	Prompts:	1. Partially conducts electricity 2. Helps turn light to electricity	1. Electrical wiring 2. Weather resistant	1. Partially conducts electricity 2. LED lights
	Key Use:	Semiconductors	Wiring, cables, converters	Semiconductors
<b>Wind turbine:</b>	Correct CRMs:	<b>Neodymium (Nd)</b>	<b>Copper (Cu)</b>	<b>Dysprosium (Dy)</b>
	Prompts:	1. Super magnets 2. Spinning magnets = electricity	1. Electrical wiring 2. Weather resistant	1. Maintains magnetic abilities 2. Infrared technology
	Key Use:	Generator supermagnets	Wiring, cables, converters, windings	Generator supermagnets
<b>Any other CRM chosen for either technology = 0 points</b>				

## Appendix 4: Correct Answers & Scoring

### Example data collection and scoring

COLLECTED IN THE FIELD (E.G., AT FESTIVAL EXHIBIT)

Customer	PRE-SHOPPING			SOLAR PV BASKET			WIND TURBINE BASKET			POST-SHOPPING		
	Task 1	Task 2	Task 3	CRM 1	CRM 2	CRM 3	CRM 1	CRM 2	CRM 3	Task 1	Task 2	Task 3
1	4	-2	28	Si	Cu	Ga	Nd	Cu	Ti	6	4	34
2	3	-5	42	Si	Li	Cu	Ti	Cu	Bi	5	2	45
G3	4	-3	19	Si	Bi	Li	Nd	Cu	Dy	7	2	31

SUM TASK ANSWERS

ASSIGN SCORES TO CRM SHOPPING ANSWERS

SUM TASK ANSWERS

Customer	PRE-SHOPPING	SOLAR PV BASKET			WIND TURBINE BASKET			POST-SHOPPING
	SUM Task 1 to 3	CRM 1	CRM 2	CRM 3	CRM 1	CRM 2	CRM 3	SUM Task 1 to 3
1	30	1	1.5	2	1	1.5	0	44
2	40	1	0	1.5	0	1.5	0	52
G3	20	1	0	0	1	1.5	2	40

CALCULATE RATIO

SUM CRM SHOPPING SCORES PER TECHNOLOGY

CALCULATE RATIO

Customer	PRE-SHOPPING	SOLAR PV BASKET	WIND TURBINE BASKET	POST-SHOPPING
	SUM/MAX	SUM	SUM	SUM/MAX
1	30/65	4.5	2.5	44/65
2	40/65	2.5	1.5	52/65
G3	20/65	1	4.5	40/65

COMBINE

MAX POSSIBLE SHOPPING SCORE = 9

Customer	PRE-SHOPPING SCORE	OVERALL SHOPPING SCORE	POST-SHOPPING SCORE
1	0.46	7	0.68
2	0.62	4	0.8
G3	0.31	5.5	0.62

OVERALL SHOPPING SCORE HELPS INFORM ON HOW PARTICIPANTS ARE INTERACTING WITH CRM CUBE INFORMATION - E.G., 7 is very high, 4 is moderate.

Assess pre to post change in score to evaluate gains (if any) in knowledge.

## Appendix 5: Import reliance & recycling key

As on the supermarket aisle, this table shows the 2023/24 CRMs and their highest associated sourcing % (either EU or non-EU) across the mining and processing stages. It also shows how much of the EU supply comes from recycling. **Green indicates the 3D block CRMs within the activity.**

CRM	Sourcing %	Main EU or non-EU supplier	EU recycling %
<b>Lithium (Li)</b>	<b>100% non-EU</b>	<b>Chile</b>	<b>0%</b>
Beryllium (Be)	100% non-EU	USA	0%
Magnesium (Mg)	100% non-EU	China	7%
Scandium (Sc)	100% non-EU	UK	0%
<b>Titanium (Ti)</b>	<b>100% non-EU</b>	<b>Kazakhstan</b>	<b>6%</b>
Vanadium (V)	100% non-EU	China	1%
Manganese (Mn)	96% non-EU	South Africa	9%
Cobalt (Co)	81% non-EU	Russia	22%
Nickel (Ni)	75% non-EU	Russia	16%
<b>Copper (Cu)</b>	<b>69% EU</b>	<b>Poland</b>	<b>30%</b>
<b>Gallium (Ga)</b>	<b>100% non-EU</b>	<b>China</b>	<b>0%</b>
Germanium (Ge)	51% EU	Belgium	2%
Arsenic (As)	60% EU	Belgium	0%
Helium (He)	94% non-EU	Qatar	1%
Flourine (F)	60% non-EU	Mexico	1%
Carbon (C)	99% non-EU	China	3%
Boron (B)	100% non-EU	Turkey	1%
Aluminium (Al)	89% non-EU	Guinea	21%
<b>Silicon (Si)</b>	<b>64% non-EU</b>	<b>Norway</b>	<b>unknown</b>
Phosphorous (P)	100% non-EU	Kazakhstan	0%
Strontium (Sr)	99% EU	Spain	0%

## Appendix 5: Import reliance & recycling key

As on the supermarket aisle, this table shows the 2023/24 CRMs and their highest associated sourcing % (either EU or non-EU) across the mining and processing stages. It also shows how much of the EU supply comes from recycling. **Green indicates the 3D block CRMs within the activity.**

CRM	Sourcing %	Main EU or non-EU supplier	EU recycling %
Yttrium (Y)	100% non-EU	China	0%
Niobium (Nb)	100% non-EU	Brazil	0%
Ruthenium (Ru)	100% non-EU	South Africa	6%
<b>Rhodium (Rh)</b>	<b>100% non-EU</b>	<b>South Africa</b>	<b>36%</b>
Palladium (Pd)	97% non-EU	Russia	33%
Antimony (Sb)	100% non-EU	Turkey	28%
Barium (Ba)	74% non-EU	China	0%
Hafnium (Hf)	78% EU	France	0%
Tantalum (Ta)	99% non-EU	Congo (DRC)	13%
Tungsten (W)	80% non-EU	China	42%
Osmium (Os)	100% non-EU	South Africa	30%
Iridium (Ir)	100% non-EU	South Africa	30%
Platinum (Pt)	100% non-EU	UK	30%
<b>Bismuth (Bi)</b>	<b>71% non-EU</b>	<b>China</b>	<b>0%</b>
LREE (La, Ce, Pr, <b>Nd</b> , Sm)	<b>100% non-EU</b>	<b>China</b>	<b>0 to 1%</b>
HREE (Eu, Gd, Tb, <b>Dy</b> , Ho, <b>Er</b> , Tm, Yb, Lu)	<b>100% non-EU</b>	<b>China</b>	<b>0 to 1%</b>

Numbers are approximate based on latest (2023) assessments of supply chain dynamics (as listed below).

**Sources:** [European Commission, Study on the Critical Raw Materials for the EU 2023 – Final Report \(2023\)](#); [Raw Materials Information Systems](#); [CRMs 2023 – SCREEN3](#).

# Some useful resources

[The VECTOR project](#)



[The EU Green Deal](#)

[The Critical Raw  
Materials Act fact  
sheet](#)



[EU Raw Materials  
Profiles](#)