SUSMAGPRO

SUSTAINABLE RECOVERY, REPROCESSING AND REUSE OF RARE-EARTH MAGNETS IN THE CIRCULAR ECONOMY

Universiteit Leiden

The Netherlands

Circular business structures in the magnet industry

An explorative approach

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LCM 2021

10th international conference on **Life Cycle Management**

Sept. 05-08, 2021

Online

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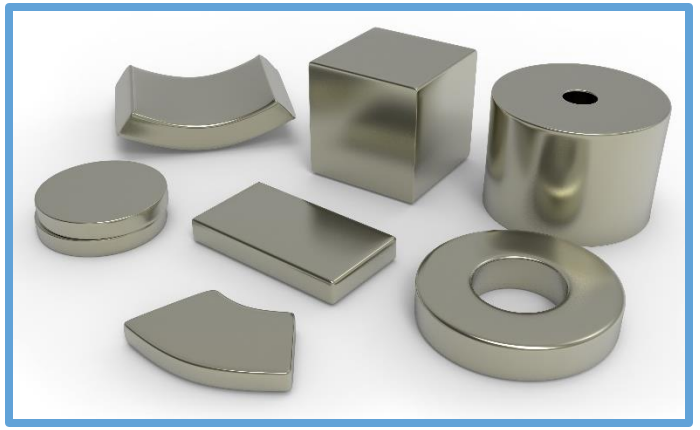
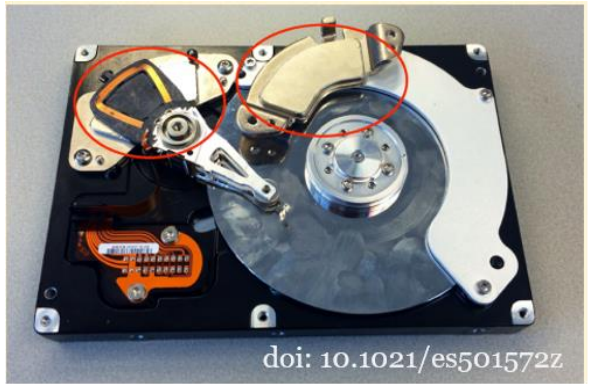
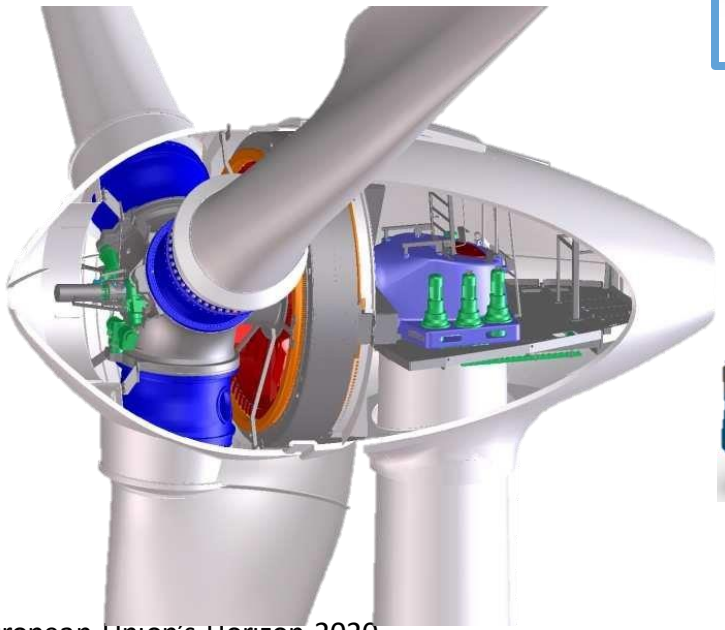
Rare Earth Magnets are crucial for many technologies

- Permanent magnets made from Rare Earths (RE) have very good magnetic properties
- Essential for e.g. loudspeakers, e-cars, laptops, smartphones, wind turbines, flat screen TVs, robots and many more
- Critical raw materials







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SUSMAGPRO: A Circular Economy for RE Magnets

- **Develop and demonstrate innovative pilot plants**
  - ✓ Waste sorting
  - ✓ Magnet extraction
  - ✓ Alloy recovery
  - ✓ Magnet production
  - ✓ Making new products

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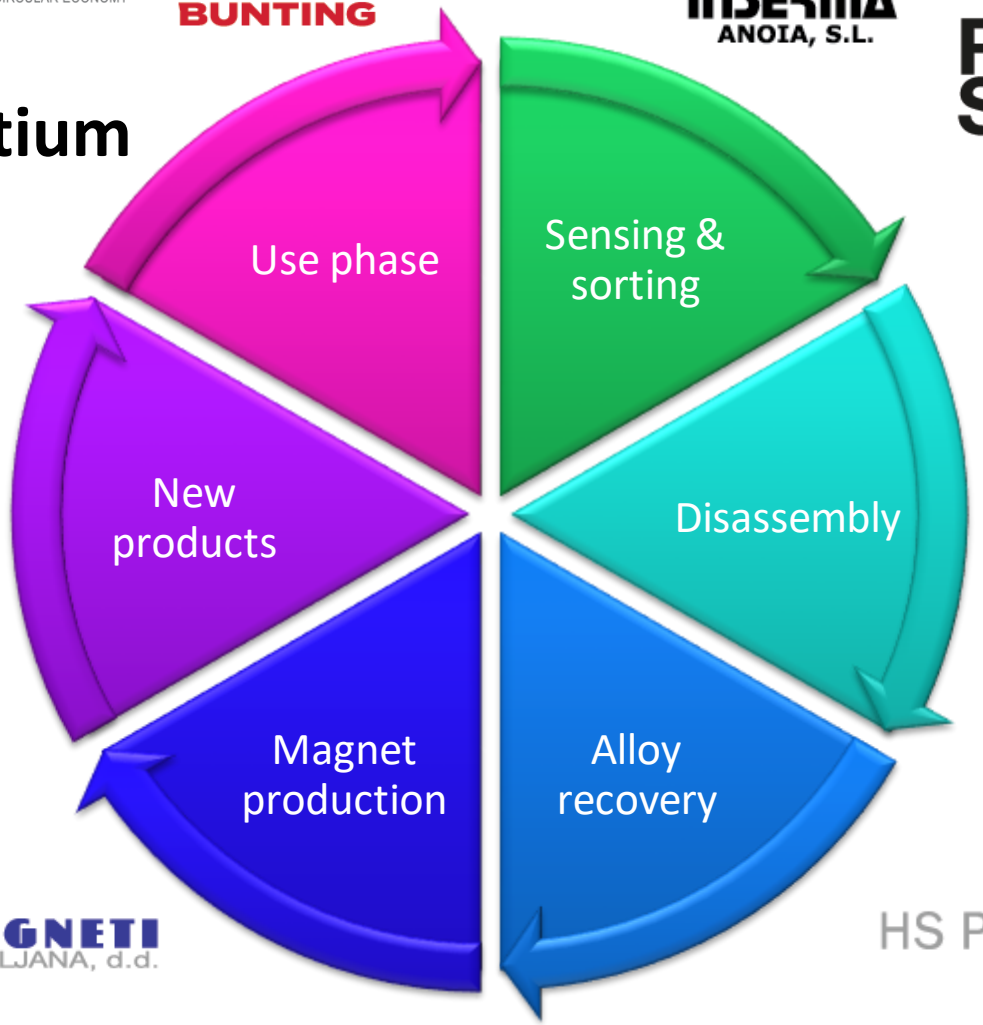
SUSMAGPRO Consortium



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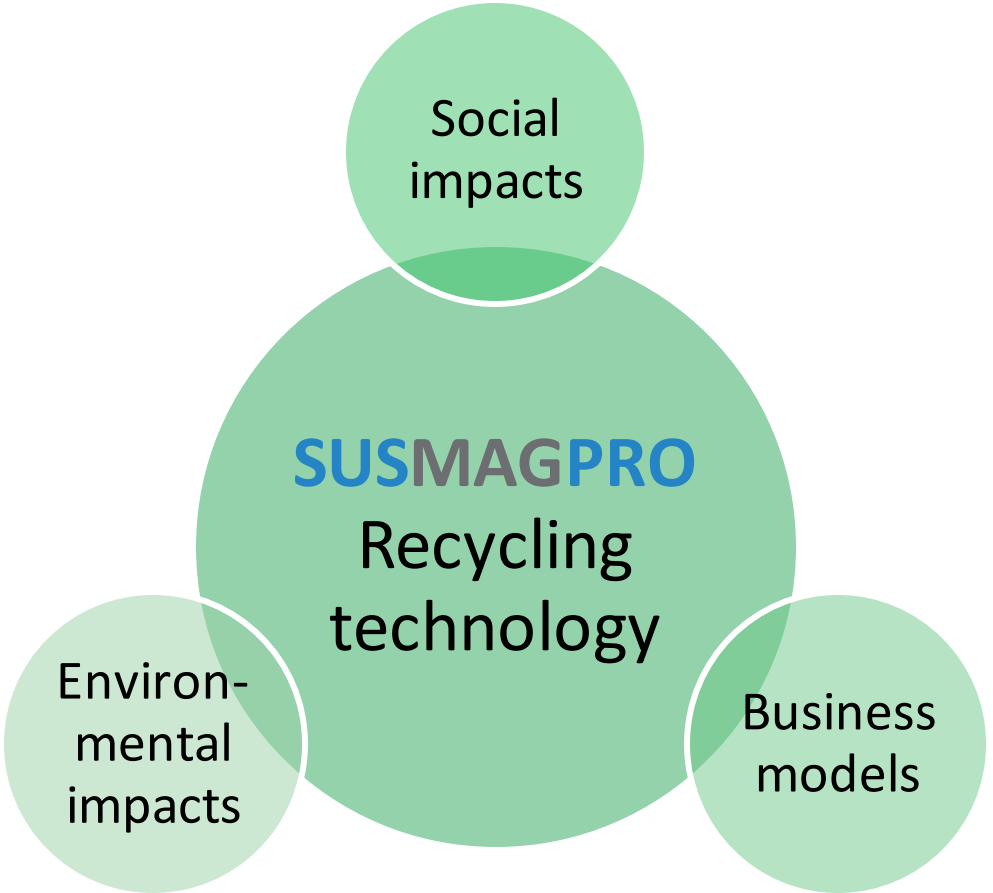
Integrated sustainability assessment

- Guiding the R&D
- Exploration of future impacts & implications

- Collaborative approach
- Online scenario workshops



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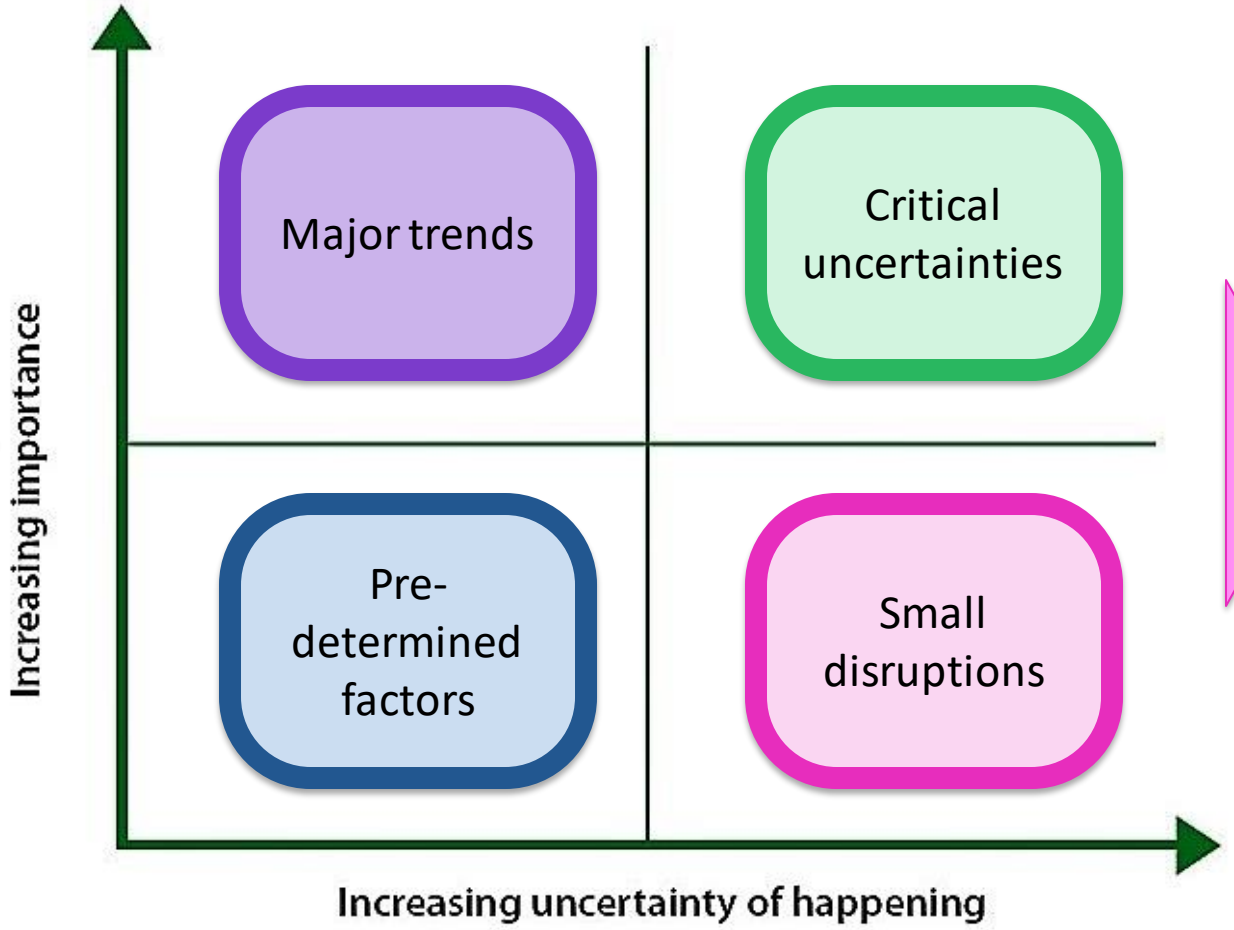
Identification → Classification → Combination

- List of trends

Recycling subsidy
Waste export rules
Waste collection infrastructure
Technology for supply chain transparency
Rare earth prices



- Distinct scenarios

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Upscaling Objectives

- Automatic sorting to extract 6 t/yr of NdFeB powders
- 4 pilot plants, producing up to 50 t/yr reusable NdFeB powders
- In 2028: produce 15% of EU demand for NdFeB

* NdFeB = neodymium-iron-boron, the magnet alloy

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From scenario to strategy

Scenarios (external)

	Trend a	Trend b	Trend c	Trend d
Scenario 1	a1	b1	c1	d1
Scenario 2	a2	b2	c2	d2
Scenario 3	a3	b3	c3	d3
Scenario 4	a4	b4	c4	d4

Strategies (internal)

	Parameter A	Parameter B	Parameter C
Strategy 1	Setting A1	Setting B1	Setting C1
Strategy 2	Setting A2	Setting B2	Setting C2
Strategy 3	Setting A3	Setting B3	Setting C3
Strategy 4	Setting A4	Setting B4	Setting C4

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Ritchey (2018). General morphological analysis as a basic scientific modelling method. *Tech Forecast & Soc Change* 126

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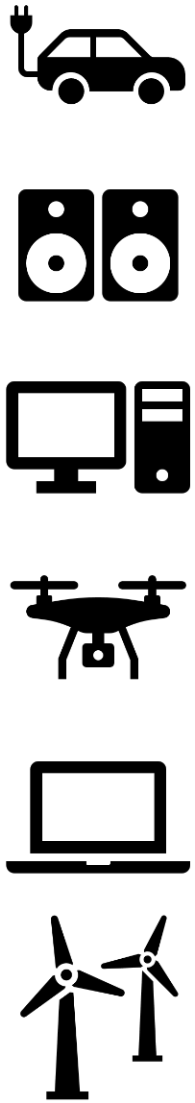
EoL products → Collection → Scrap analysis → Liberation → Recovery → Magnet manuf. → Product

Magnet recycling chain



B2B take-back

In-shop collection

Municipal WEEE coll.

Social workplace

Automated detection

Detector-aided, manual

Manual

Robotic

HPMS

HPMS+ HDDR

HPMS + recasting

Sintering

SDS-MIM

SDS-extrusion

IM

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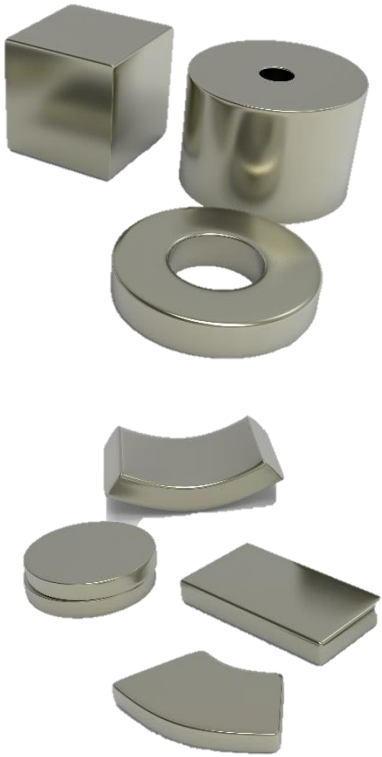

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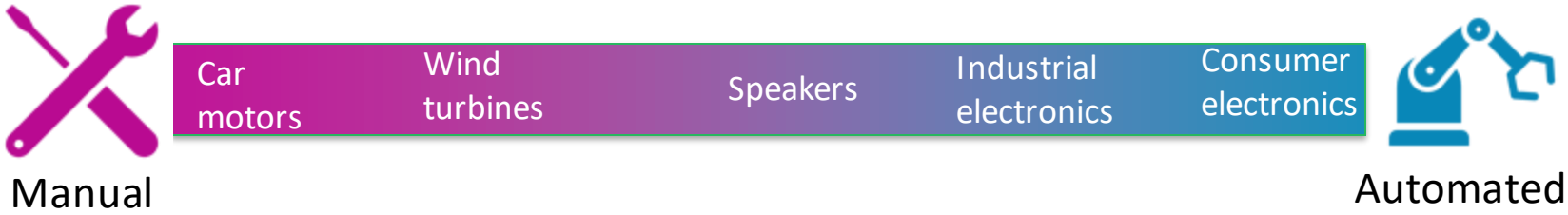
Strategies

- Collection: demagnetization, prevent export
- Scrap analysis: manufacturer data sheets, new rapid identification methods
- Liberation:



- Recovery: depends on impurities and oxidation of magnets (see MaXycle.eu)

- Magnet manufacturing: variety of options, adjustable to consumer needs

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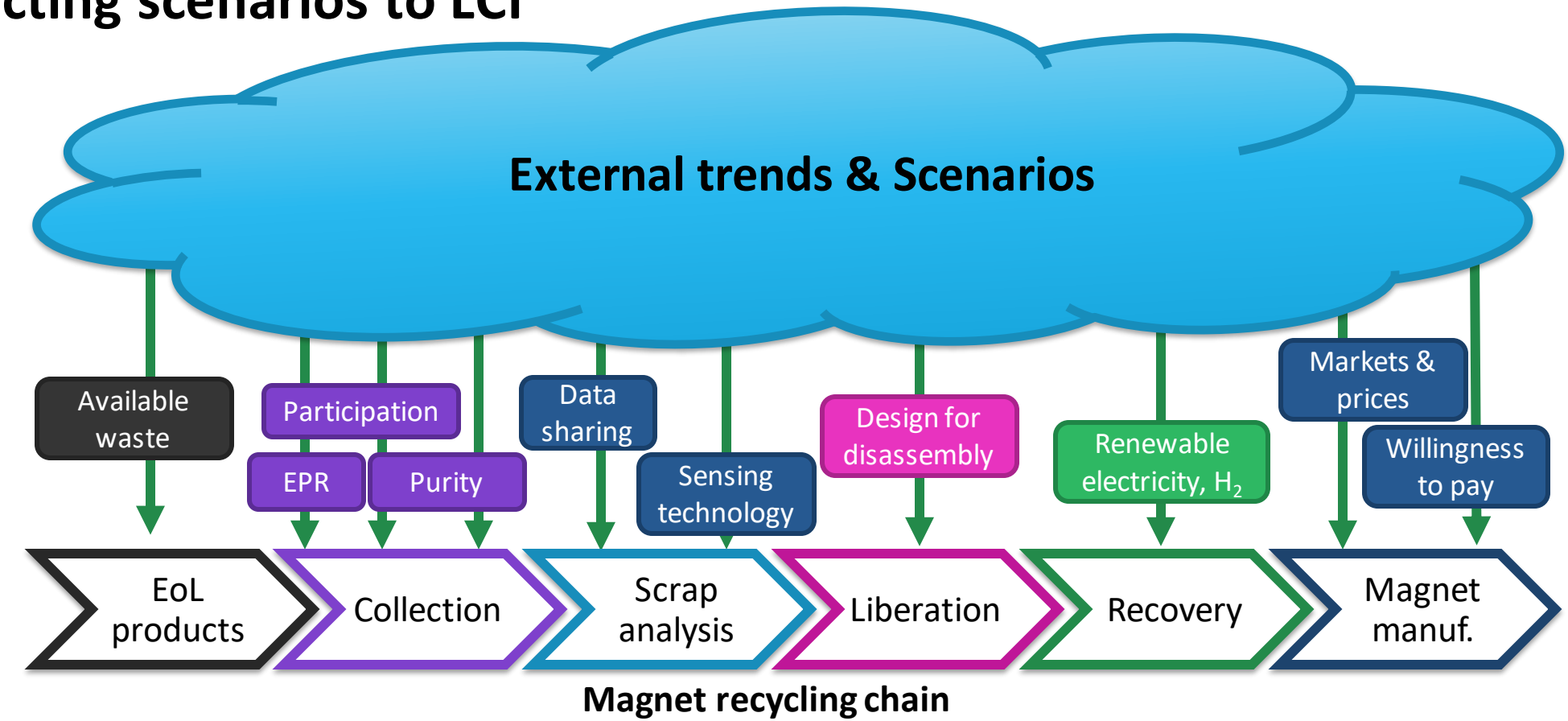
Connecting scenarios to LCI



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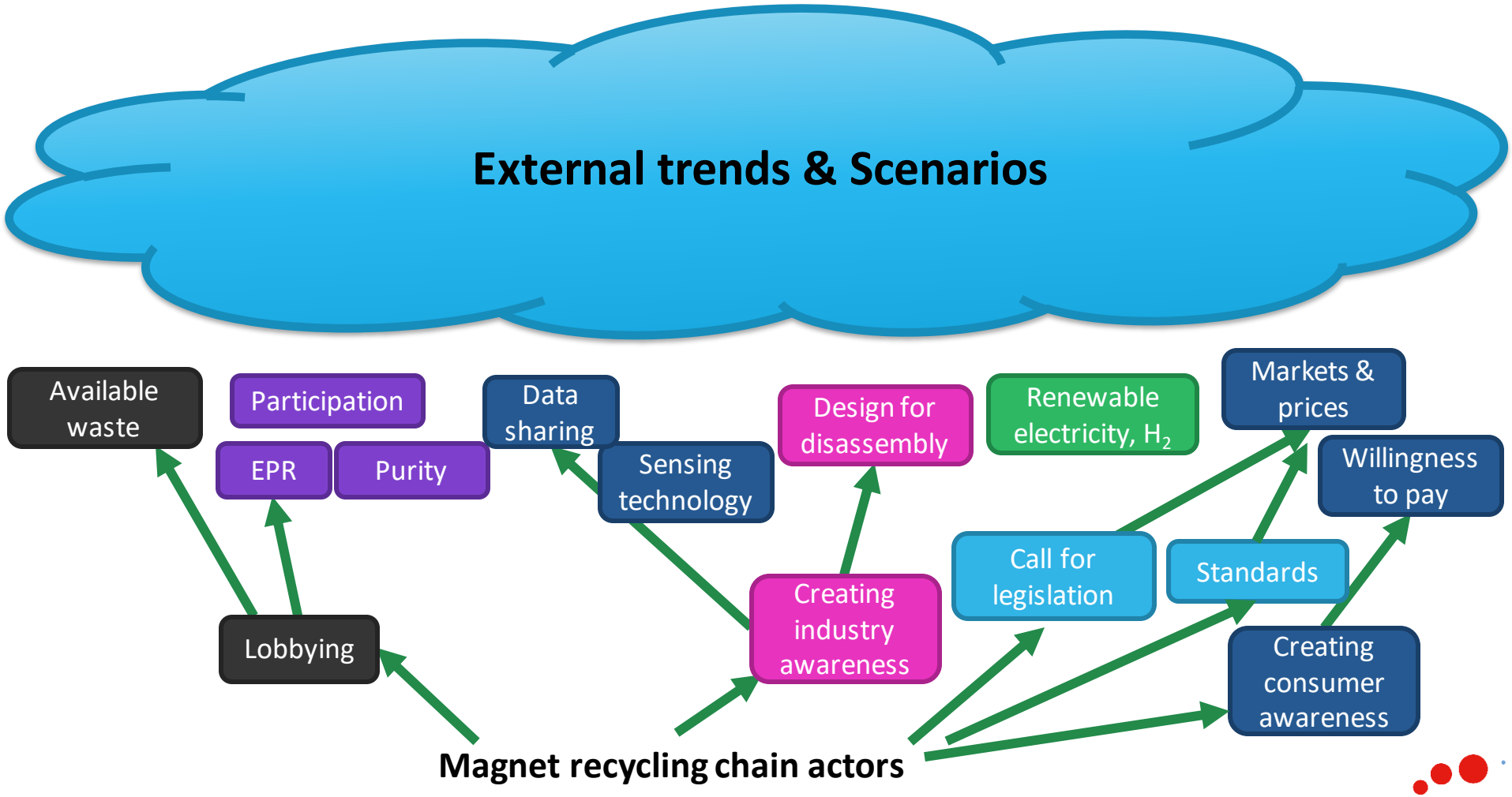

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Connecting scenarios to LCI

Advanced LCA software tools:

- Brightway
- Activity Browser
  - Graphical interface
  - Scenario parameters
  - Excel export & import

https://brightway.dev
https://github.com/LCA-ActivityBrowser

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Conclusions

- SUSMAGPRO is developing and upscaling technologies for magnet recycling
- Future implications explored with scenarios
- Strategic choices improve the business models

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Special thanks to Brenda Miranda Xicotencatl & René Kleijn

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