
INTERNATIONAL
ELECTRIC VEHICLE SYMPOSIUM & EXHIBITION


# Raw Material Use in Electric Vehicles A Sustainability Assessment

Presented by Marta Iglesias-Émbil

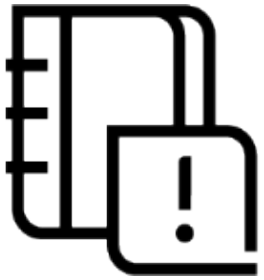
Lyon, 21/05/2019

# Main **Goal**

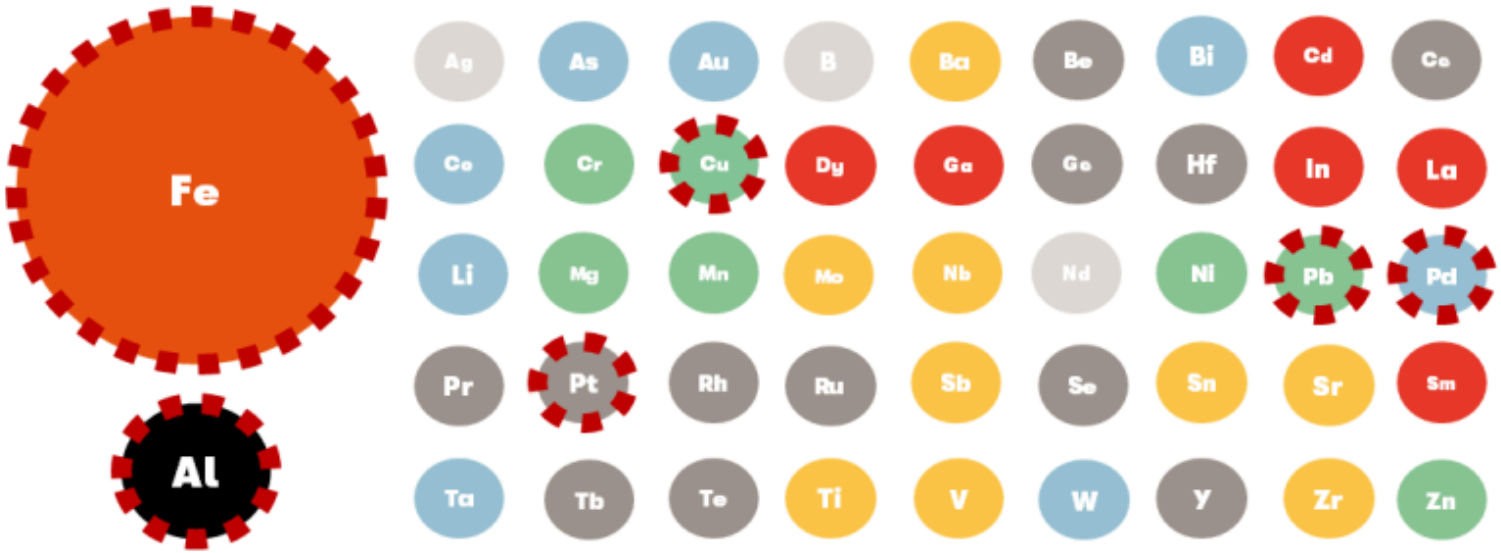
To determine the **metals content** within an **ICEV** and a **BEV** in **mass** and **rarity** terms in order to…

mitigate potential **supply risks**

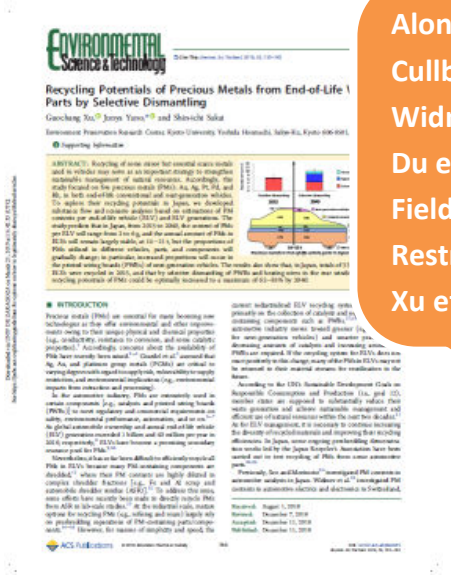
# Some **facts**…



# Car metal content, recycling, sales, demand…




# A huge **lack of knowledge** about a car metals' content, current and potential demand, and future EoL stock… and a **growing interest** in it…


Environmental Science & Technology

Recycling Potentials of Precious Metals from End-of-Life V Parts by Selective Dismantling

Guocheng Xu, Jinyu Yano,* and Shinichi Sakai

Environmental Preservation Research Center, Kyoto University, Yoshida Honmachi, Sakyo-ku, Kyoto 606-8501,

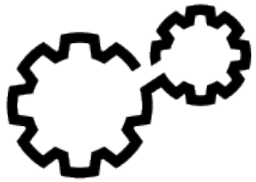
Alonso et al. (2011)
Cullbrand and Magnusson (2012)
Widmer et al. (2015)
Du et al. (2015)
Field et al. (2017)
Restrepo et al. (2017)
Xu et al. (2019)

ProSUM
Prospecting Secondary raw materials in the Urban mine and Mining wastes

ORAMA
Optimising quality of information in RAw MAterials data collection across Europe

SCRREEN
Solutions for Critical Raw materials - a European Expert Network

# Methodology



Thermodynamic Rarity [Rarity]

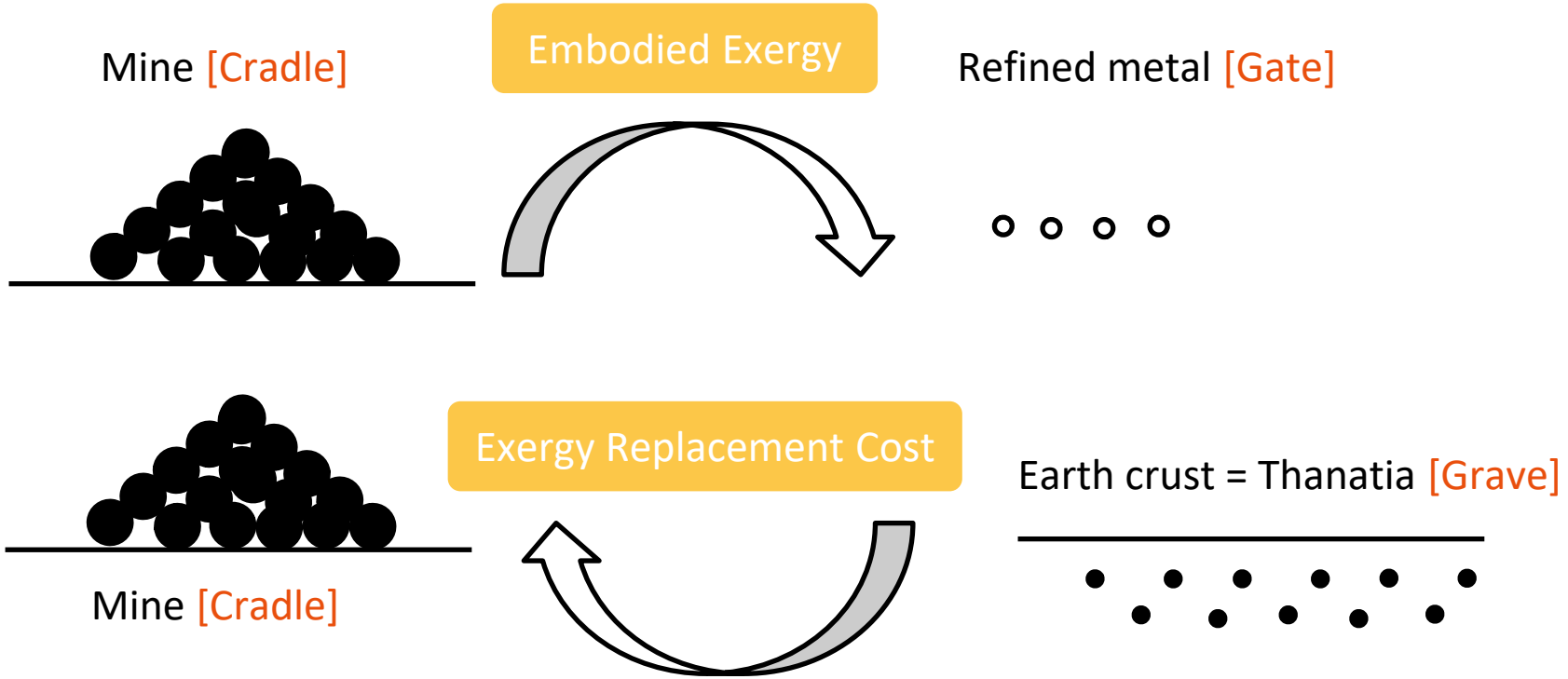
Data gathering

Rarity assessment

# Why rarity? Searching for a common scale for resource efficiency…

| | Mass | Price | Rarity |
|---|---|---|---|
| Physical indicator |  |  |  |
| Objective |  |  |  |
| Universal |  |  |  |
| Quality is taken into account |  |  |  |
| Associated to societal value |  |  |  |
| No apples with oranges mixing |  |  |  |
| No volatility |  |  |  |
| No arbitrariness |  |  |  |

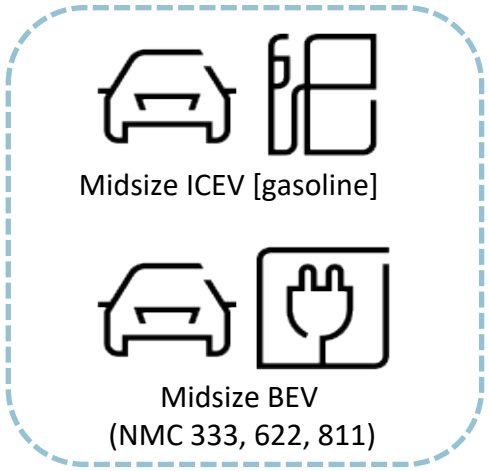
# Rarity…a Resource Use Indicator




**Source: Valero, A. and A. Valero Delgado. 2015. Thanatia: The destiny of the Earth's mineral resources**

# Data gathering & Rarity Assessment

[Company internal IT Systems]




Data consolidation
[in mass]

Rarity assessment
R [part] = ∑ Rarity [metals]

[MacroExcel]

[Mass, g]

| Part name | Ag [g] | […] |
|---|---|---|
| E-Engine | | |
| […] | | |

[Rarity, kJ]

| Part name | Ag [kJ] | […] |
|---|---|---|
| E-Engine | | |
| […] | | |

# Research questions

Which metals are in ICEV and BEV contained?

In which quantity?

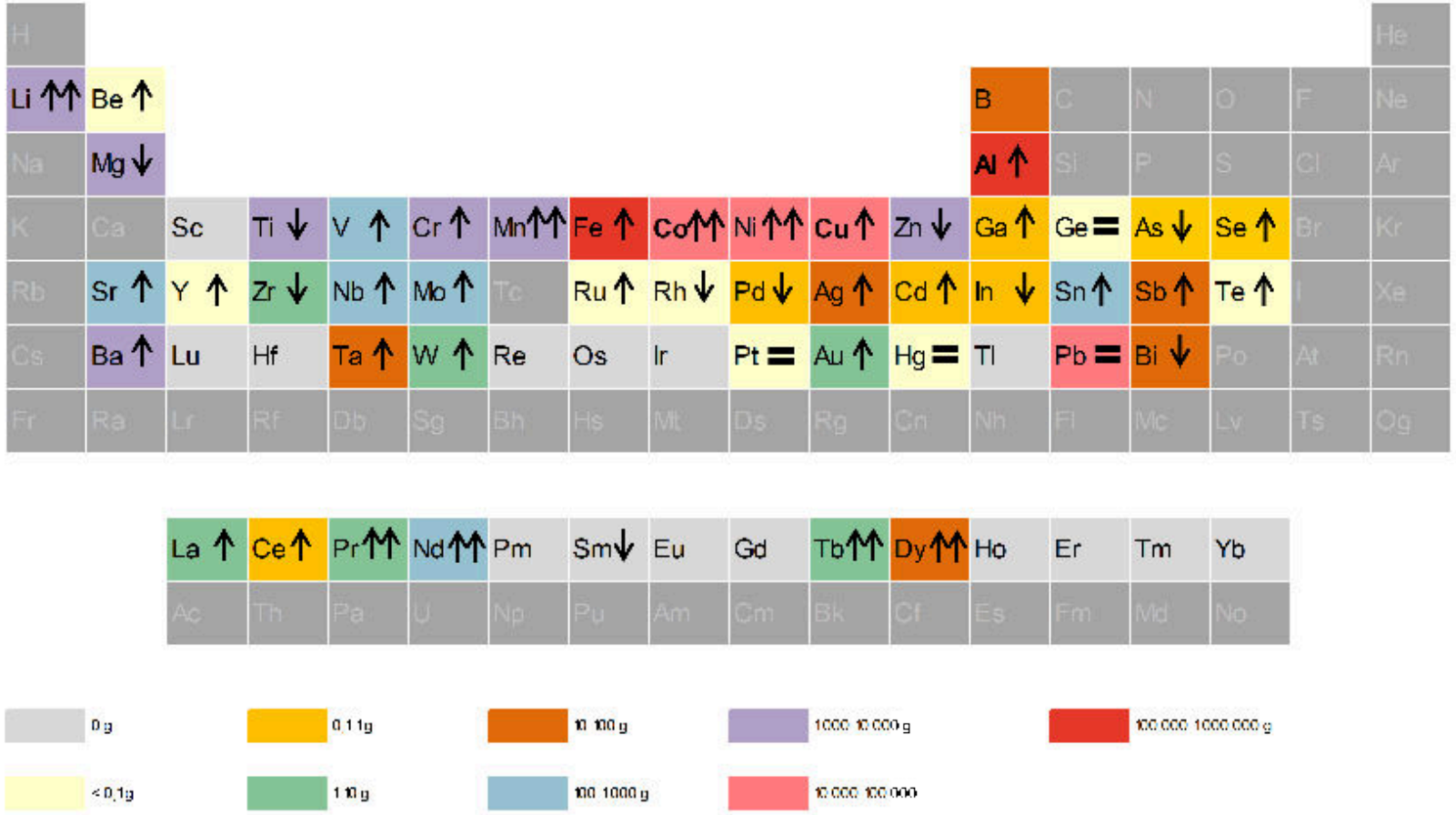
Where are these metals located?

What is the difference in metals content between ICEV and BEV?

What is the difference between the mass and the rarity assessment?

What is the effect of the evolution of the battery in BEV? (in mass and rarity)

# Metals contained within a BEV



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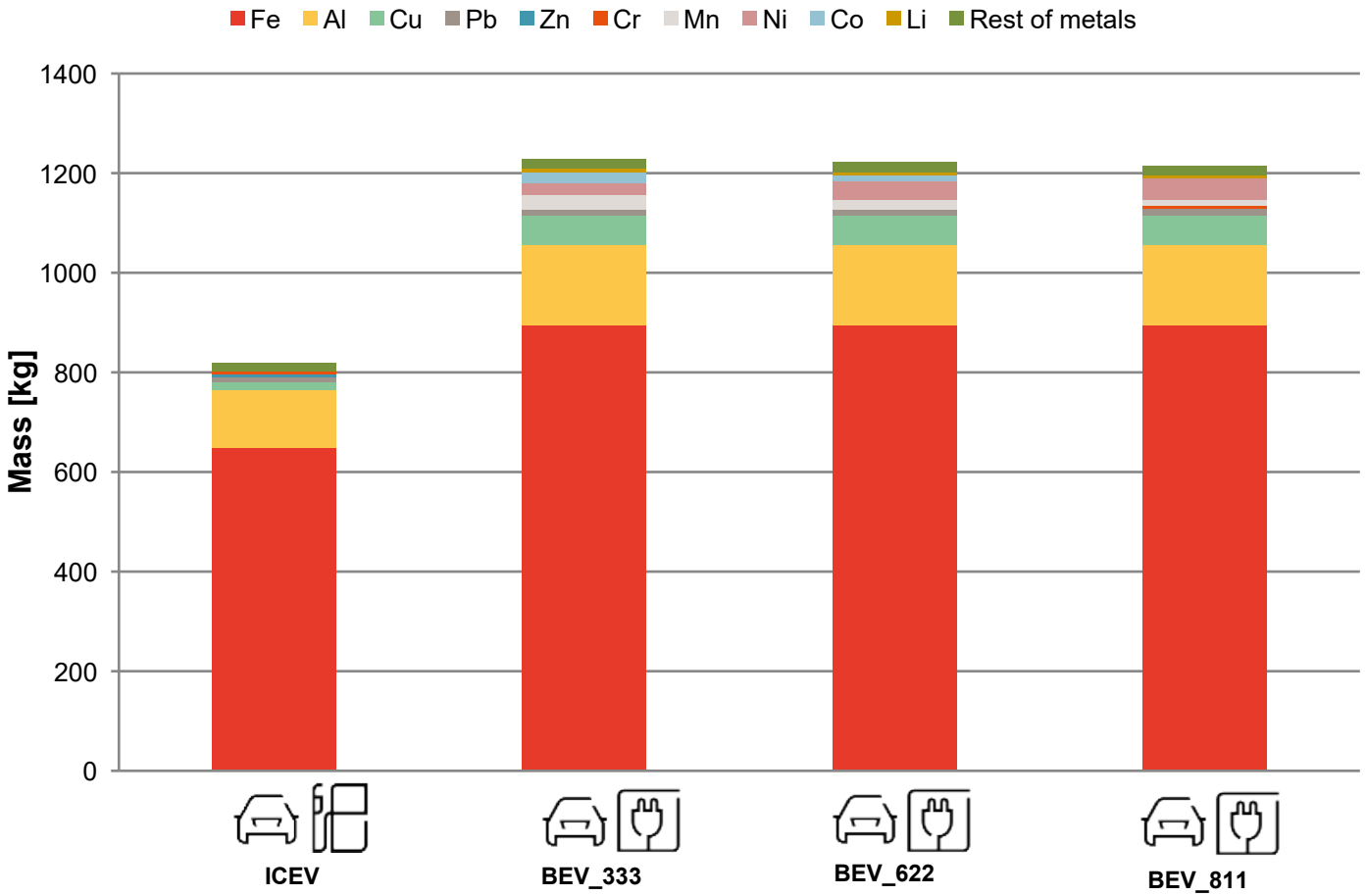
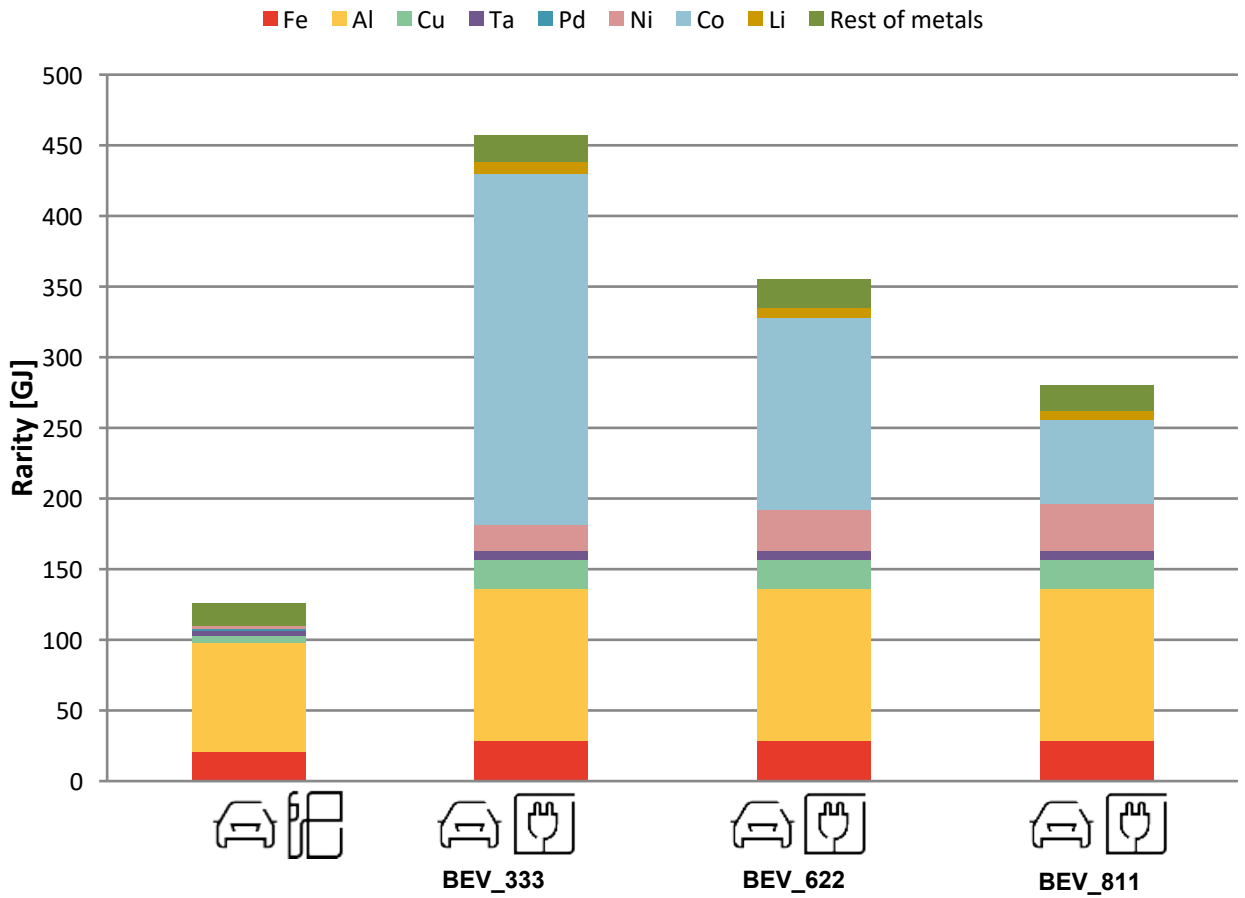
# Metals in terms of mass…



# Metals in terms of rarity…



# Valuable metals…valuable parts

| Part name | Rarity [GJ] | Total Rarity Share | Metal 1 Rarity Share | Metal 2 Rarity Share | Metal 3 Rarity Share | Metal 4 Rarity Share | Metal 5 Rarity Share |
|---|---|---|---|---|---|---|---|
| HV-Battery (module) | 175 | 83,33% | Cobalt 65,75% | Nickel 13,56% | Lithium 3,44% | Copper 3,05% | Manganese 0,41% |
| Electric engine | 3 | 1,43% | Copper 8,91% | Neodymiun 2,37% | Cobalt 1,63% | Nickel 0,21% | Dysprosium 0,17% |
| Control unit for HV-battery | 3 | 1,43% | Tantalum 15,36% | Copper 14,94% | Palladium 3,09% | Gold 1,70% | Platinum 1,19% |
| Power and control electronics for electric drive | 2 | 0,95% | Tantalum 23,58% | Gold 20,67% | Copper 12,80% | Palladium 6,70% | Nickel 4,79% |

# Conclusions

A car is a ROAD MINE

Rarity increases with electrification

Antagonism between climate change and resource use fighting strategies

Rarity decreases with the evolution of HV-batteries

Antagonism between substitution & reduction and recycling strategies

Rarity assess resource use but does not reflect recyclability (Future research)

# References

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[2] Cullbrand K, Magnusson O. The Use of Potentially Critical Materials in Passenger Cars. 2012.

[3] Du, X., E. Restrepo, R. Widmer, and P. Wäger. 2015. Quantifying the distribution of critical metals in conventional passenger vehicles using input-driven and output-driven approaches: A comparative study. *Journal of Material Cycles and Waste Management* 17(2): 218-228.

[4] Field FR, Wallington TJ, Everson M, Kirchain RE. Strategic Materials in the Automobile: A Comprehensive Assessment of Strategic and Minor Metals Use in Passenger Cars and Light Trucks. Environ Sci Technol 2017;51:14436-44. doi:10.1021/acs.est.6b06063.

[5] Ortego, Abel, Valero, Alicia, Valero, Antonio, Restrepo, Eliette, 2017. Vehicles and critical raw materials. A sustainability assessment using thermodynamic rarity. Ind. Ecol. http://dx.doi.org/10.1111/jiec.12737. First published: 10 March 2018.

[6] Restrepo, E., A. N. Løvik, P. Wäger, R. Widmer, R. Lonka, and D. B. Müller. 2017. Stocks, flows and distribution of critical metals in embedded electronics in passenger vehicles. *Environmental Science & Technology* 51(3): 1129-1139.

[7] Widmer, R., X. Du, O. Haag, E. Restrepo, and P. A. Wäger. 2015. Scarce metals in conventional passenger vehicles and end-of-life vehicle shredder output. *Environmental Science & Technology* 49(7): 4591-4599.

[8] Valero, A. and A. Valero Delgado. 2015. Thanatia: The destiny of the Earth's mineral resources: A cradle-to-cradle thermodynamic assessment. Hackensack, NJ, USA: World Scientific.

# Thank you!

For further questions,

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