



Evaluation of Strategic Metals Envisaging the Sustainable Management

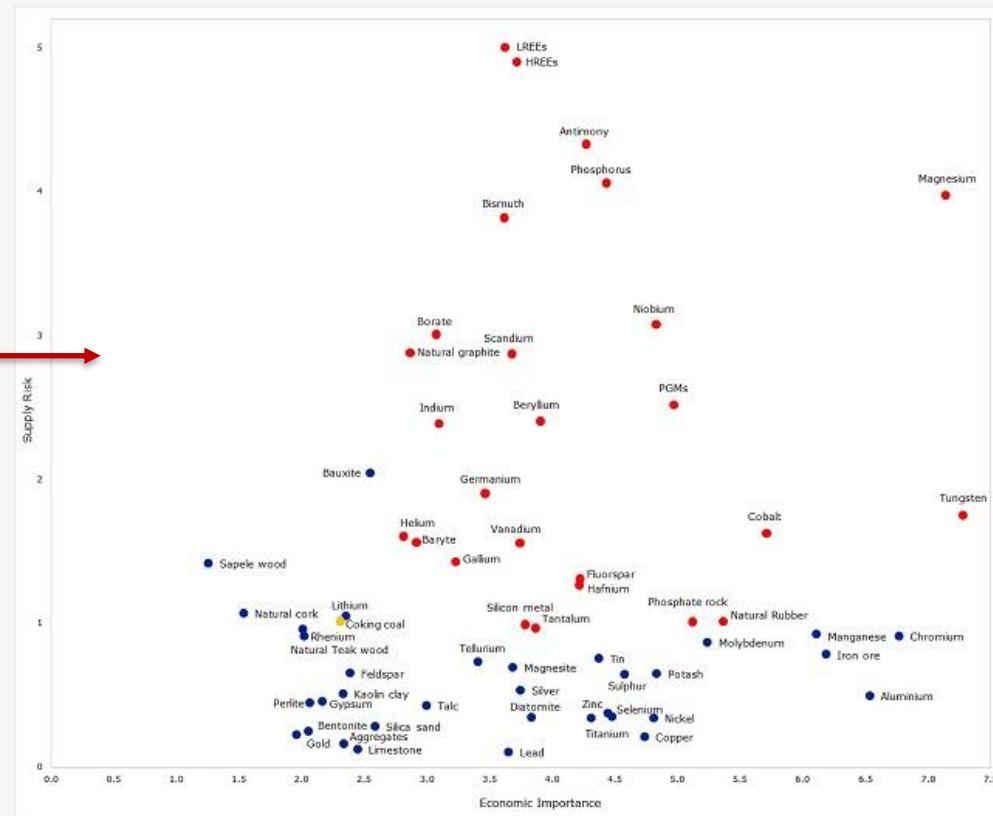
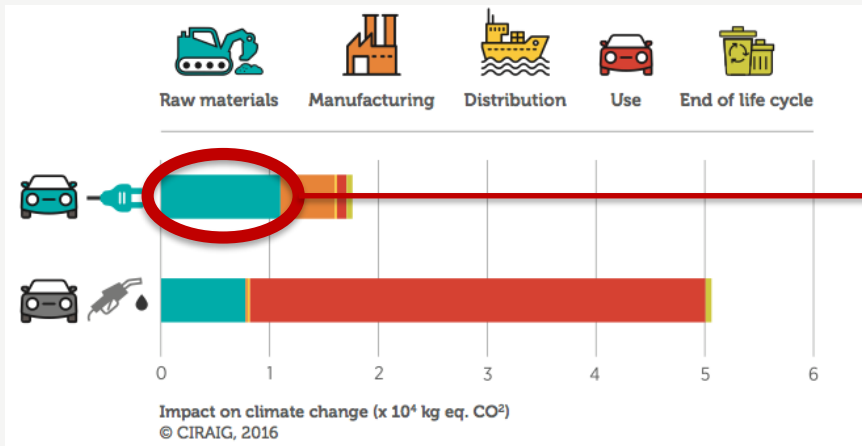
Flow and Stock Analysis of Neodymium within ELVs

Author: Francisco Pinheiro Vaz Capucha
Supervisor: Prof. Dr. Fernanda Maria Ramos da Cruz Margarido
Co-Supervisor: Dr. Patrícia De Carvalho Baptista

Problem Definition

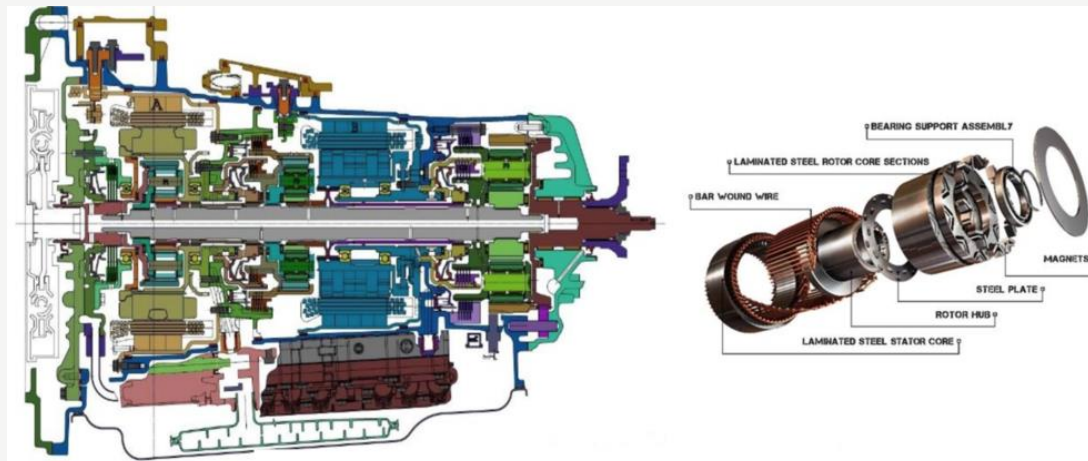
- Is the ZEV industry sustainable?
- Or are there any constraints?
 - If so, can it be improved?

Critical Raw Materials in ZEVs



Why neodymium?

- Set to become the most critical Rare Earth;
- Used in the vast majority of ZEVs powertrain and electrical power steering.



Goal – Prospect neodymium ‘Urban Mine’ within European ZEV

1. Create a detailed database of ZEVs in Portugal and EU;
2. Determine the most accurate possible ‘average neodymium content’ per ZEV model;
3. Perform the flow and stock analysis of the element;
4. Interpret the results to assess the element recovery potential and its impact in the industry.

Go with

1.

		PHEV										
Brand/Model	Euro Car Segment	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total	
Audi		0	0	0	0	694	9686	7191	8564	4712	30847	
PHEV since 2014	A3 - Sportsback E-tron					694	9677	4054	6320	3080	23825	
PHEV since 2015	Q7 E-tron						9	3137	2244	1632	7022	
BMW		0	0	0	487	4535	9054	24807	35475	40853	115211	
PHEV since 2015	530e iPerformance						4	109	5578	12750	18441	
PHEV since 2015	330e iPerformance						179	8277	9469	6834	24759	
PHEV since 2015	225xe						114	4493	8394	10464	23465	
PHEV since 2015	X5 xDrive40e/45e					50	1786	4296	3881	2648	12661	
PHEV since 2013	i3 EREV				487	3467	4993	5383	6041	5646	26017	
PHEV since 2014	Série i i8					1018	1907	1407	832	1352	6516	
PHEV since 2015	Série 7						71	842	1280	1159	3352	
Chevrolet/Opel		0	312	5418	3923	910	185	7	2	0	10757	
EREV since 2010	Volt/Ampera		312	5418	3923	910	185	7	2	0	10757	
Hyundai		0	0	0	0	0	0	0	2288	4762	7050	
PHEV since 2017	Ioniq								2288	4762	7050	
Kia		0	0	0	0	245	37	700	4661	12578	18221	
PHEV since 2017	Niro								2232	8464	10696	
PHEV since 2014	Optima					245	37	700	2429	4114	7525	
Land Rover		0	0	0	0	0	0	0	0	4332	4332	
PHEV since 2018	Range Rover P400e									4332	4332	
Mercedes-benz		0	0	0	0	136	6939	13149	17300	12260	49784	
PHEV since 2015	Class C - C350e						5743	9137	5341	3646	23867	

n Mine'

Portugal

average

2.

Electric PC							
Brand	Model	Segment & Class	Motor Type	Permanent Magnet Motor	Electric Power Steering	Seat Adjustment	Neodymium Speakers
BMW	Série i3	B (Subcompact luxury vehicle)	BMW eDrive "Hybrid synchronous motor"	1	1	0	0
	Active E	C (compact car)	Permanent Magnet Synchronous Motor	1	1	0	0
	C-Zero	A (City Car)	Permanent Magnet Synchronous Motor	1	1	0	0
Citroen	Berlingo	M (Leisure Activity Vehicle)	Permanent Magnet Synchronous Motor	1	1	0	0
	C-Elysee	C (Sedan)	Permanent Magnet Synchronous Motor	1	1	0	0
	E-Mehari	JB (Small SUV)	Permanent Magnet Synchronous Motor	1	1	0	0
Ford	Focus	C (Compact Car)	Permanent Magnet Synchronous Motor	1	1	0	0
Hyundai	Ioniq	C (Compact Car)	Permanent Magnet Electric motor	1	1	1	0
	Kauai	JB (Crossover SUV)	Permanent Magnet Electric motor	1	1	1	0
Jaguar	iPace	JD (Compact Luxury Crossover SUV)	Permanent Magnet Synchronous Motor	2	1	2	11
Kia	Soul	JB (Subcompact Crossover SUV)	Permanent Magnet AC Synchronous Motor	1	1	0	0
	Niro	JB (Subcompact Crossover)	Permanent Magnet AC Synchronous Motor	1	1	0	0
Mercedes-benz	Classe B	M (Compact Executive, MPV)	Asynchronous Induction Motor	0	1	0	0
Mitsubishi	i-Miev	A (City Car)	Permanent Magnet Synchronous Motor	1	1	0	0
Nissan	Leaf	C (compact car)	Permanent Magnet AC Synchronous Motor	1	1	0	0
	e-NV200	M (Leisure Activity Vehicle)	Permanent Magnet AC Synchronous Motor	1	1	0	0
Peugeot	Ion	A (City Car)	Permanent Magnet Synchronous Motor	1	1	0	0
	Partner	M (Leisure Activity Vehicle)	Permanent Magnet Synchronous Motor	1	1	0	0
Renault	Zoe	B (Supermini)	Synchronous electric motor rotor coil	0	1	0	0
	Fluence	C (compact car)	Synchronous electric motor rotor coil	0	1	0	0

try.

Future

- Expand the project to include other critical elements and components within ZEVs;
- Study the industrial implementation of recovery methods.



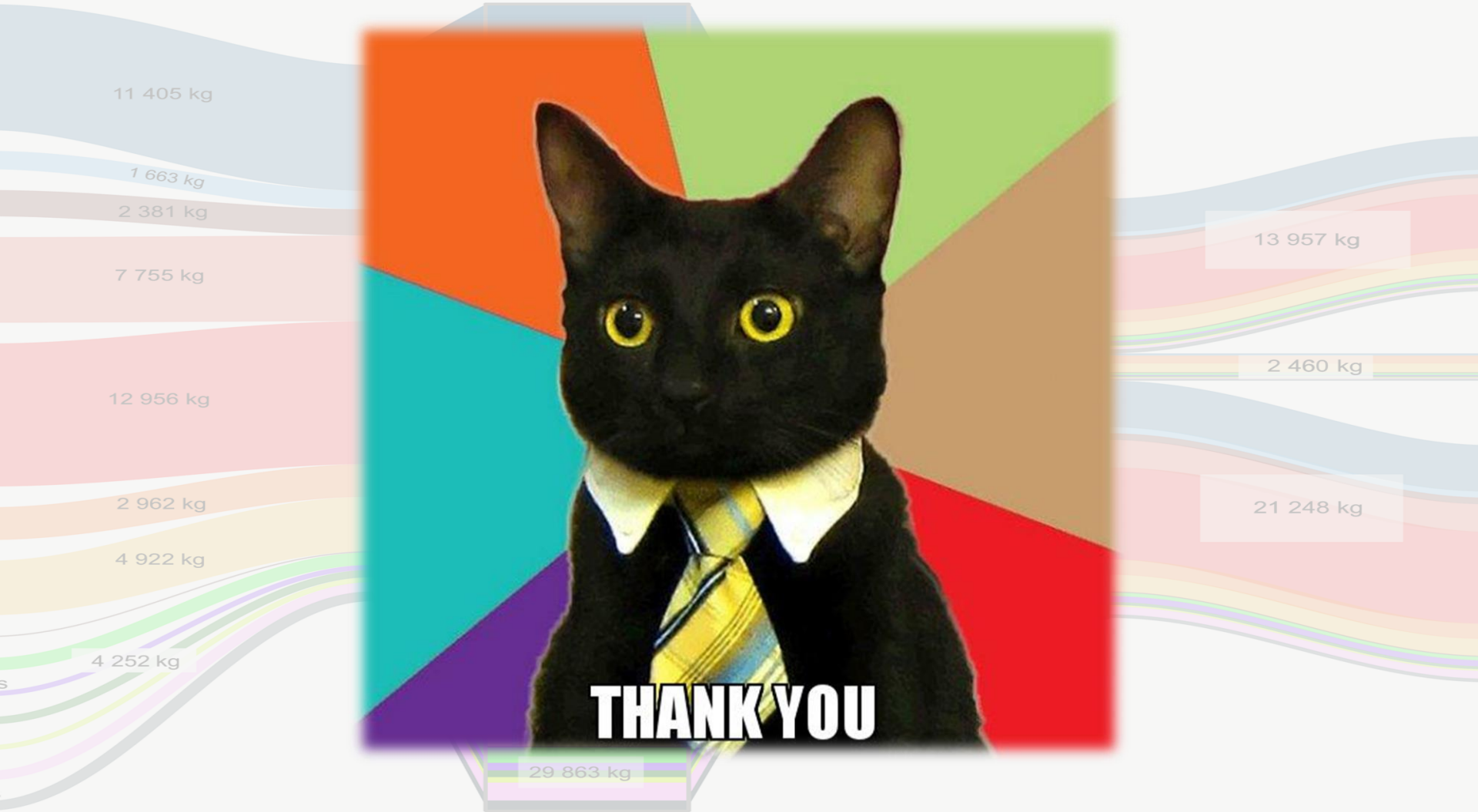


Image References

- http://equiterre.org/sites/fichiers/images/graphique_en.png
- <https://www.greencarcongress.com/2016/02/20160219-ct6.html>
- https://ec.europa.eu/growth/sectors/raw-materials/specific-interest/critical_pt
- https://www.recovery-worldwide.com/en/artikel/bhs-sonthofen-increases-amount-of-copper-recovered-from-motor-armatures-and-electric-motors_3411717.html
- https://www.greencarreports.com/news/1107864_electric-car-battery-warranties-compared