

A scenic photograph of a sunset over a mountain range. The sun is low on the horizon, casting a warm glow of orange and yellow across the sky. The mountains are silhouetted against the bright light, creating a layered effect. The overall mood is serene and hopeful.

Industry Decarbonisation - The Importance of Low Carbon Hydrogen and P2X

APGH 24

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***Product Development Manager
Lynas Rare Earths***

Lynas and Relevance to Green Energy Value Chains

- An Australian company listed on the ASX
- Operating in both Australia and Malaysia for over 10 years
- Ethical and environmentally responsible producer of rare earth materials
- World's only significant producer of separated rare earth materials outside of China



- Expertise in Solid Oxide Formulation, Synthesis and Characterization (Rare Earths and Zr based materials)
- **Unique Capability to produce a variety of Solid Oxides, from Mining to End Products**
- Deep understanding of relevant raw material markets
- Expanding Refining and Manufacturing Capabilities
- Ability to respond to fast moving situations
- **Willingness to Collaborate with the Industry To establish a Diverse, Sustainable and Resilient Supply Chain**

Rare Earths

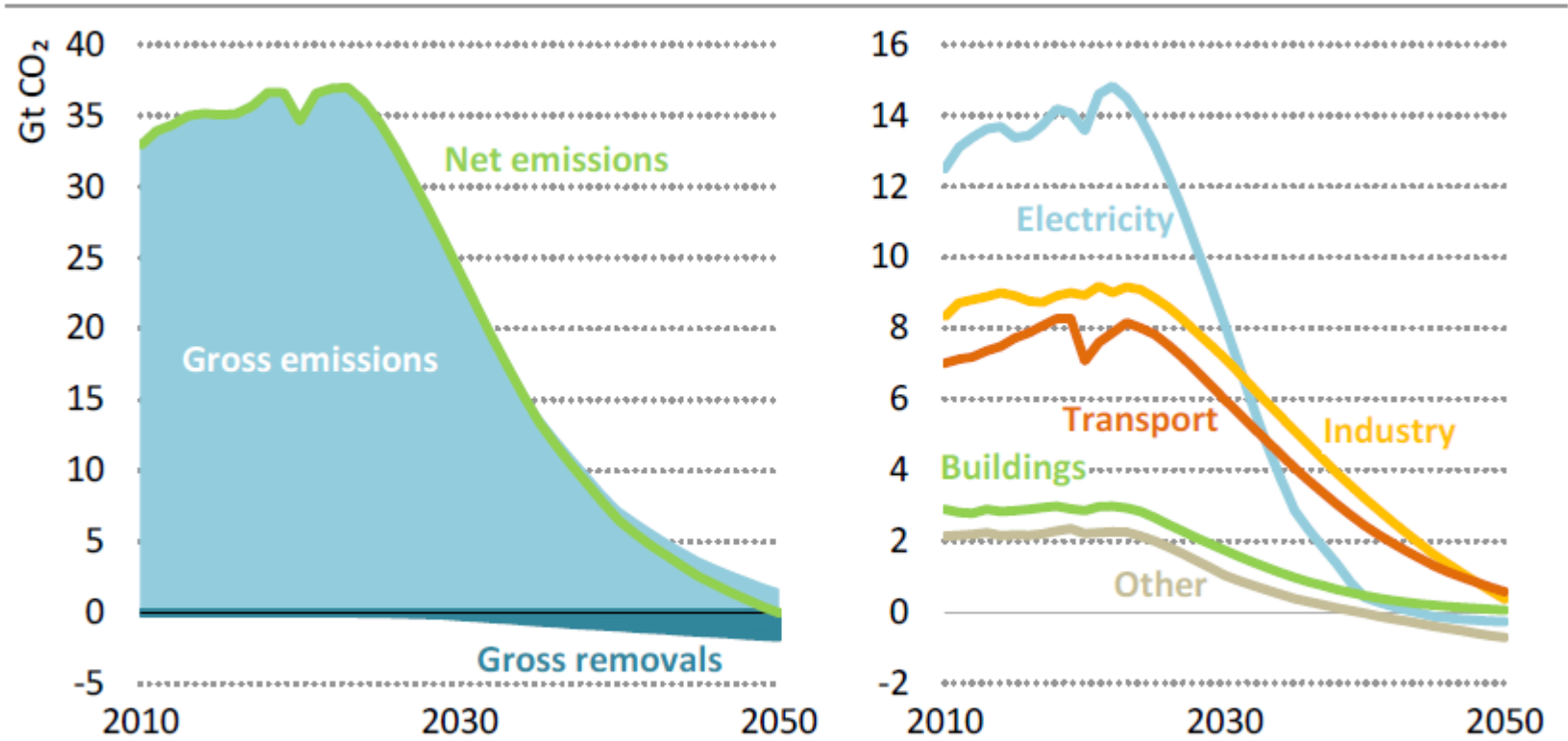
- Include all the 15 elements in the lanthanoid group
- Originally thought to be rare, however many of them are fairly abundant
- Cerium is the 25th most abundant material in the Earth's crust
- Geochemical tendency to co-exist in very small amounts attached to common ores and elements.
- Became popular when they could help greatly reduce the size of the brick-sized old cell phones.
- Since then, implemented in all sorts of new technology and have also become important in the creation of powerful rare earth magnets.

1 H Hydrogen 1.008 1																	2 He Helium 4.0026 2
3 Li Lithium 6.940 2-1	4 Be Beryllium 9.012 2-1											5 B Boron 10.810 2-3	6 C Carbon 12.011 2-4	7 N Nitrogen 14.007 2-5	8 O Oxygen 15.999 2-6	9 F Fluorine 18.998 2-7	10 Ne Neon 20.180 2-8
11 Na Sodium 22.99 2-8-1	12 Mg Magnesium 24.30 2-8-2											13 Al Aluminium 26.98 2-8-3	14 Si Silicon 28.085 2-8-4	15 P Phosphorus 30.97 2-8-5	16 S Sulfur 32.06 2-8-6	17 Cl Chlorine 35.45 2-8-7	18 Ar Argon 39.95 2-8-8
19 K Potassium 39.098 2-8-8-1	20 Ca Calcium 40.078 2-8-8-2	21 Sc Scandium 44.956 2-8-9-2	22 Ti Titanium 47.867 2-8-10-2	23 V Vanadium 50.942 2-8-11-2	24 Cr Chromium 51.996 2-8-13-1	25 Mn Manganese 54.938 2-8-13-2	26 Fe Iron 55.845 2-8-14-2	27 Co Cobalt 58.933 2-8-15-2	28 Ni Nickel 58.693 2-8-16-2	29 Cu Copper 63.546 2-8-18-1	30 Zn Zinc 65.380 2-8-18-2	31 Ga Gallium 69.723 2-8-18-3	32 Ge Germanium 72.630 2-8-18-4	33 As Arsenic 74.922 2-8-18-5	34 Se Selenium 78.971 2-8-18-6	35 Br Bromine 79.904 2-8-18-7	36 Kr Krypton 83.798 2-8-18-8
37 Rb Rubidium 85.468 2-8-18-8-1	38 Sr Strontium 87.620 2-8-18-8-2	39 Y Yttrium 88.906 2-8-18-9-2	40 Zr Zirconium 91.224 2-8-18-10-2	41 Nb Niobium 92.906 2-8-18-12-1	42 Mo Molybdenum 95.940 2-8-18-13-1	43 Tc Technetium [97] 2-8-18-13-2	44 Ru Ruthenium 101.07 2-8-18-15-1	45 Rh Rhodium 102.91 2-8-18-16-1	46 Pd Palladium 106.42 2-8-18-18	47 Ag Silver 107.87 2-8-18-18-1	48 Cd Cadmium 112.41 2-8-18-18-2	49 In Indium 114.82 2-8-18-18-3	50 Sn Tin 118.71 2-8-18-18-4	51 Sb Antimony 121.76 2-8-18-18-5	52 Te Tellurium 127.60 2-8-18-18-6	53 I Iodine 126.90 2-8-18-18-7	54 Xe Xenon 131.29 2-8-18-18-8
55 Cs Cesium 132.91 2-8-18-18-8-1	56 Ba Barium 137.33 2-8-18-18-8-2	57-71 Ln Lanthanides	72 Hf Hafnium 178.49 2-8-18-32-10-2	73 Ta Tantalum 180.95 2-8-18-32-11-2	74 W Tungsten 183.84 2-8-18-32-12-2	75 Re Rhenium 186.21 2-8-18-32-13-2	76 Os Osmium 190.23 2-8-18-32-14-2	77 Ir Iridium 192.22 2-8-18-32-15-2	78 Pt Platinum 195.08 2-8-18-32-17-1	79 Au Gold 196.97 2-8-18-32-18-1	80 Hg Mercury 200.59 2-8-18-32-18-2	81 Tl Thallium 204.38 2-8-18-32-18-3	82 Pb Lead 207.20 2-8-18-32-18-4	83 Bi Bismuth 208.98 2-8-18-32-18-5	84 Po Polonium [209] 2-8-18-32-18-6	85 At Astatine [210] 2-8-18-32-18-7	86 Rn Radon [222] 2-8-18-32-18-8
87 Fr Francium [223] 2-8-18-32-18-8-1	88 Ra Radium [226] 2-8-18-32-18-8-2	89-103 Actinides	104 Rf Rutherfordium [267] 2-8-18-32-32-10-2	105 Db Dubnium [268] 2-8-18-32-32-11-2	106 Sg Seaborgium [269] 2-8-18-32-32-12-2	107 Bh Bohrium [270] 2-8-18-32-32-13-2	108 Hs Hassium [271] 2-8-18-32-32-14-2	109 Mt Meitnerium [278] 2-8-18-32-32-15-2	110 Ds Darmstadtium [281] 2-8-18-32-32-16-2	111 Rg Roentgenium [282] 2-8-18-32-32-17-2	112 Cn Copernicium [285] 2-8-18-32-32-18-2	113 Nh Nihonium [286] 2-8-18-32-32-18-3	114 Fl Flerovium [289] 2-8-18-32-32-18-4	115 Mc Moscovium [290] 2-8-18-32-32-18-5	116 Lv Livermorium [293] 2-8-18-32-32-18-6	117 Ts Tennessine [294] 2-8-18-32-32-18-7	118 Og Oganesson [294] 2-8-18-32-32-18-8
f-block																	
4f-block	57 La Lanthanum 138.91 2-8-18-18-9-2	58 Ce Cerium 140.12 2-8-18-18-9-2	59 Pr Praseodymium 140.91 2-8-18-21-8-2	60 Nd Neodymium 144.24 2-8-18-22-8-2	61 Pm Promethium [145] 2-8-18-23-8-2	62 Sm Samarium 150.36 2-8-18-24-8-2	63 Eu Europium 151.96 2-8-18-25-8-2	64 Gd Gadolinium 157.25 2-8-18-25-9-2	65 Tb Terbium 158.93 2-8-18-27-8-2	66 Dy Dysprosium 162.50 2-8-18-28-8-2	67 Ho Holmium 164.93 2-8-18-29-8-2	68 Er Erbium 167.26 2-8-18-30-8-2	69 Tm Thulium 168.93 2-8-18-31-8-2	70 Yb Ytterbium 173.05 2-8-18-32-8-2	71 Lu Lutetium 174.97 2-8-18-32-9-2		
5f-block	89 Ac Actinium [227] 2-8-18-32-18-9-2	90 Th Thorium 232.04 2-8-18-32-20-9-2	91 Pa Protactinium 231.04 2-8-18-32-20-9-2	92 U Uranium 238.03 2-8-18-32-21-9-2	93 Np Neptunium [237] 2-8-18-32-22-9-2	94 Pu Plutonium [244] 2-8-18-32-24-8-2	95 Am Americium [243] 2-8-18-32-25-8-2	96 Cm Curium [247] 2-8-18-32-25-9-2	97 Bk Berkelium [247] 2-8-18-32-27-8-2	98 Cf Californium [251] 2-8-18-32-28-8-2	99 Es Einsteinium [252] 2-8-18-32-29-8-2	100 Fm Fermium [257] 2-8-18-32-30-8-2	101 Md Mendelevium [258] 2-8-18-32-31-8-2	102 No Nobelium [259] 2-8-18-32-32-8-2	103 Lr Lawrencium [261] 2-8-18-32-32-8-2		

The nature and Scale of the task

* IEA 2023

Energy sector gross emissions and removals, total net CO₂ emissions, and net emissions by sector in the NZE Scenario, 2010-2050



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Energy sector CO₂ emissions are reduced 65% by 2035 and reach net zero by 2050, with residual emissions of 1.7 Gt balanced by atmospheric removals of the same magnitude

Hydrogen and Power to X Value Chains

- L Initiation
- L Pilot/Demo
- L Prototype
- L Commercial

