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Rare Earth Elements (REE) used in the energy transition

These are the main usage of REE and other strategic metals and minerals. Many other current uses are possible and possibly, many others will be discovered.

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Rubidium (Rb)	Photoelectric cell	✓	Used for the manufacturing of photocells and in special glasses
	Evacuated tube gas receiver		
	Nuclear medicine (heart muscles examination)		
	Space vehicles		
	Steam turbines	✓	
	Thermo-electric generators (magnetic fields regul.)	✓	

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Scandium (Sc)	Leak detector in electrical circuits	✓	Alloyed it – makes metals harder and lighter. Main use: high-end bicycle frames and baseball bats.
	Material for space activities		
	Seed germination		
	High intensity lights	✓	

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Strontium (Sr)	Nuclear battery	✓	Modern 'glow-in-the-dark' paints and plastics contain strontium aluminate
	Luminous buoy, weather station	✓	
	Beta-radiation source		
	Phosphorescent paint	✓	
	Fireworks		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Kalium / Potassium	Medical use – respiratory equipment -		Potassium hydroxide is not a REE – yet is often used in combination with REE.
	Agricultural use - Fertilizer	✓	
	Luxury industry – tanning leather and dyeing textiles		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Boron (B)	Nanotechnology		General applications including are: ceramics, high-hardness or abrasive compounds, metal coatings, detergents, bleaching agents, insecticides
	Medical use - anti-inflammatory effects		
	Fiberglass and borosilicate glassware	✓	
	Semiconductors	✓	
	Magnets		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Ytterbium (Yb)	In X-rays when electricity is not available		Improves steel refining properties
	High degree of resistance in the electric field		

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Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Caesium (Cs)	Atomic clock		Caesium compounds is as a drilling fluid. It is also used to make special optical glasses.
	Photoelectric cell	✓	
	Infrared lamp		
	Nuclear fuel		
	Nuclear medicine		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Thorium (Th)	Material for atomic reactors		Thorium has the potential to be used as a fuel for generating nuclear energy.
	Coating for lamp filament	✓	
	Jacket for gas lamps		
	Supplies for laboratory glassware	✓	
	Gas lights (prep. welsbach mantle)		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Praseodymium (Pr)	Stone for lighters		The high-strength alloy it forms with magnesium is used in aircraft engines.
	Permanent magnets	✓	
	Carbon arc		
	Paint for ceramics	✓	
	To color crystals and lenses		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Lutetium (Lu)	Atomic power plants		Lutetium oxide is used to make catalysts for cracking hydrocarbons in the petrochemical industry.
	Electronic components in TV		
	Petrochemical industry		
	Cancer therapy		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Gallium (Ga)	Quartz thermometer	✓	It is used in the Blu-ray technology, mobile phones, blue and green LEDs and pressure sensors for touch switches
	Integrated circuit computer memory	✓	
	TV screen		
	Transistor diode for laser	✓	
	Semi-conductors (reduced melting point)	✓	

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Neodymium (Nd)	Photochromic eyeglass lenses coloring	✓	Alloyed with iron and boron to make very strong permanent magnets. End market use: when miniaturized, many electronic devices, including mobile phones, microphones, loudspeakers
	Permanent magnet ceramic capacitor	✓	
	Glasses, lenses, laser manufacturing	✓	
	Tinting lenses for welders		

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Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Lanthanum (La)	Hydrogen storage	✓	Compounds containing lanthanum are used extensively in carbon lighting applications, such as studio lighting and cinema projection
	Stone for lighters		
	Battery electrodes	✓	
	Exhaust gas catalyst	✓	
	Camera lenses	✓	
	Optical glasses	✓	

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Hafnium (Hf)	Atomic reactor control		Hf is used in filaments and electrodes. Some semiconductor fabrication processes use its oxide for integrated circuits at 45nm and smaller
	Submarine propulsion		
	Vacuum tube gas receiver	✓	
	Incandescent lamps		
	Residual radiation elimination		
	Neutron capture (nuclear research)		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Cerium (Ce)	Exhaust gas catalyst		Cerium is used in flat-screen TVs, low-energy light bulbs and floodlights
	Stone for lighters		
	TV glass polishing powder		
	Light bulbs	✓	
	Carbon Arc Lamp	✓	
	Hydrocarbon catalyst (residual cleaning of ovens)	✓	

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Erbium (Er)	Steel-Vanadium alloys Glass staining	✓	In fibre-optic cables and long-distance telephone lines, Er an amplifier of the signal
	Porcelain stains	✓	
	Various metallurgical uses	✓	
	Telecommunication	✓	

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Samarium (Sm)	Permanent magnet ceramic capacitor	✓	Samarium's main use is in samarium-cobalt alloy magnets for headphones, small motors and pickups for some electric guitars
	Neutron receptor in nuclear reactors		
	Carbon arc (Arc lighting) for the film industry		
	Optical glass	✓	
	Absorption of infrared rays		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Tellurium (TE)	Vulcanization of rubber		Bismuth telluride and lead telluride are semi-conducting materials that have been used in thermoelectric devices either as sources of electricity or for cooling
	Fuses manufacturing	✓	
	Lead protection in accumulators	✓	
	Electrical resistance cables	✓	
	Thermocouples manufacturing	✓	
	Malleability of Cu and stainless steel		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Yttrium (Y)	Color TV manufacturing		Yttrium oxide in glass makes it heat- and shock-resistant, and is used for camera lenses. Yttrium oxide is suitable to making superconductors
	Magnetic properties	✓	
	Acoustic energy transmitter and transducer	✓	
	Antioxidant (Vanadium and other metals)	✓	
	Filter for lasers and radars	✓	

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Niobium (Nb)	Steel manufacturing		Niobate ceramics can be used to make capacitors, single crystals of compounds such as lithium niobate and potassium niobate. They are crystals for optoelectronics and electronics.
	Superconductor in space programs		
	Cutting tool	✓	
	Manufacture of pipes	✓	
	Manufacture of super magnets	✓	
	Electric welding electrodes	✓	
	Medals manufacturing		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Zirconium (Zr)	Coating for metals	✓	The most important use of zirconium is in nuclear reactors for cladding fuel rods, for alloying with uranium, and for reactor-core structures
	Exhaust gas catalyst	✓	
	Ammunition detonation fuse		
	Furnace lining		
	Oxygen meter	✓	
	Nuclear energy		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Dysprosium (Dy)	Aircraft metal	✓	It is used for permanent magnets with end use in electronics. The demand for this REE is expected to grow rapidly.
	Optical memory	✓	
	Permanent magnet	✓	
	Laser manufacturing	✓	
	Nuclear control		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Europium (Eu)	Color TV - cathode-ray tubes		The primary use of Eu is in red phosphors for optical displays and TV screens
	Mercury lamps manufacturing		
	Neutron collector (nuclear energy)		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Gadolinium (Gd)	Chromium-steel alloys	✓	Gadolinium-based contrast agents (GBCAs) help doctors see abnormal tissues in magnetic resonance imaging (MRI) scans with more detail.
	Permanent magnet	✓	
	Component in X-ray tubes		
	Memory for Computers	✓	
	Neutron collector		
	Color TV tube manufacturing (incl. phosphorus)		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Beryllium (Be)	Clock spring		Mixing beryllium with Co or Ni increases the electrical and thermal conductivity.
	Windows for x-ray tubes		
	Anti-spark tools		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Terbium (Tb)	Fluorescent lamps		Lasers, semiconductor devices, and phosphorous
	Semiconductor industry		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Thulium (Tm)	Computers component manufacturing	✓	Tm is used in portable X-rays and medical lasers for surgery
	Aerospace and nuclear industry		
	Medical industry		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Tantalum (Ta)	Electronic components (capacitors)	✓	Tantalum is used in electrolytic capacitors & corrosion-resistant chemical equipment. Final application: miniaturized electrical circuitry.
	Heating filament inside vacuum tube		
	Cutting tools		
	Balance weights		
	Lenses for cameras	✓	

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Iridium (Go)	Radiation against cancer		Iridium's primary use is a hardening agent for platinum.
	Needles for injections		
	Metric rules – pattern		
	Spark plugs (helicopter)		
	Fountain pen nib		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Indium (In)	Solar cell, mirror	✓	Indium tin oxide (ITO) is an important part of touch screens, flatscreen TVs and solar panels.
	Welding for glass, bearing	✓	
	Regulatory rod for atomic reactor		
	Photoelectric cell	✓	
	Transistors	✓	
	Blood tests, lungs		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Titanium (Ti)	Polymer catalyst	✓	Surgical applications such as in joint replacements (especially hip joints) and tooth implants
	Heat exchangers	✓	
	Aircraft engines		
	Pins for fracture (prosthesis)	✓	
	Pigment, paint, paper		

Metal / Mineral	Strategic use	Energy Transition	Particularity / Main use
Selenium (Se)	Copy machines	✓	Selenium has excellent photoconductive properties
	Solar cell	✓	
	Stain for red glass		
	Anti-dandruff (shampoo)		
	Medicine (general use)		
	Photovoltaic panels	✓	
	Light meters	✓	