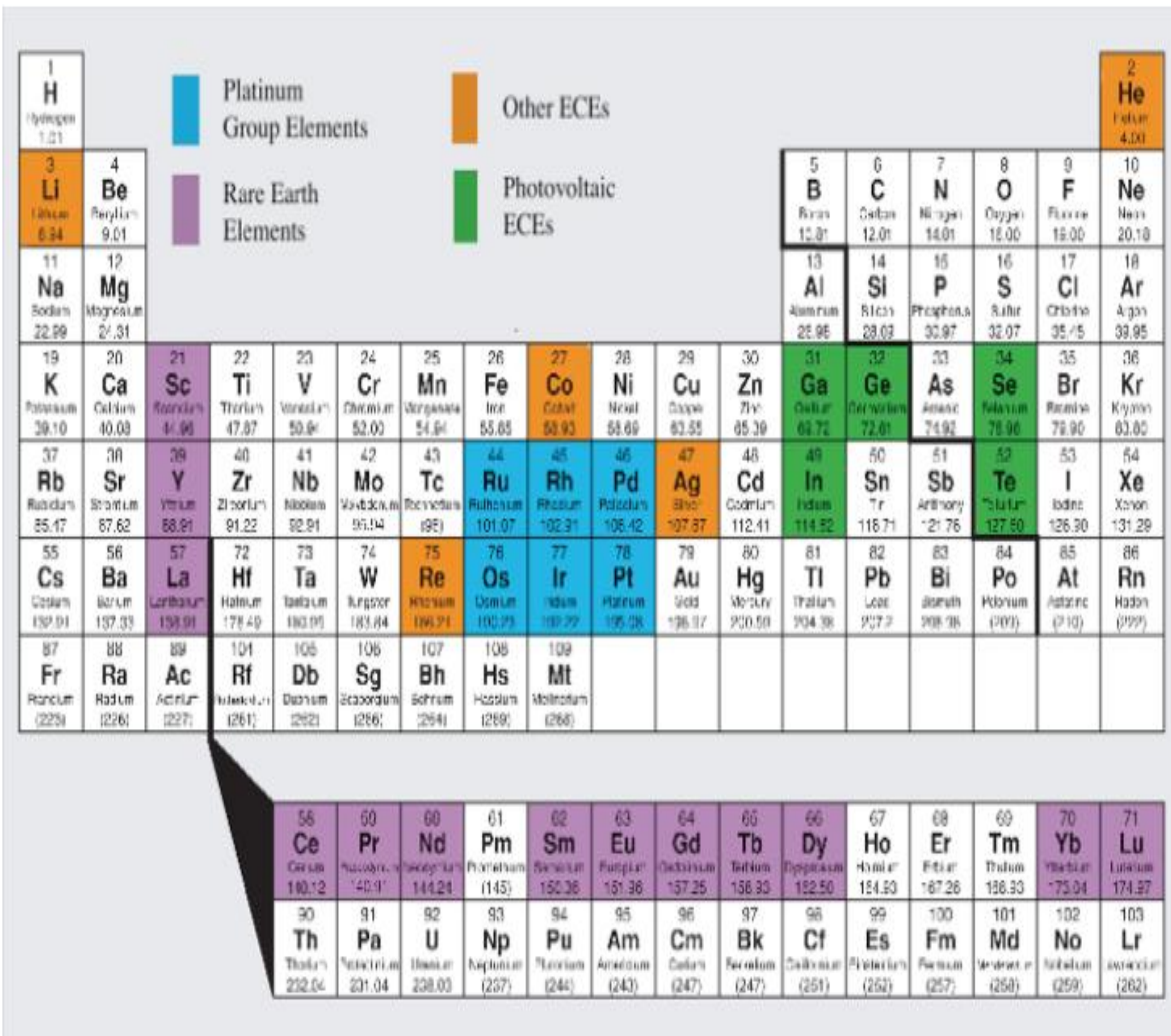
BRIEF INTRODUCTION TO TECHNOLOGY METALS AND ENERGY CRITICAL ELEMENTS (ECEs)

The twin pressure for increasing demand for energy and concerns about climate changes have brought a number of chemical elements that were once laboratory curiosities; as one of the most sought after elements. We have quietly but obviously transformed our civilization into the age of Technology Metals and ECEs.

Mendeleev's Periodic table of Elements



The Technology Metals i.e. Molybdenum (Mo), Rhenium (Re), Tellurium (Te), Selenium (Se), Germanium (Ge), Cadmium (Cd), Indium (In), Gallium (Ga), Vanadium(V), Scandium (Sc) and ECEs i.e. gallium (Ga), germanium (Ge), selenium (Se), indium (In), and tellurium (Te) though used in small quantities, provide essential chemical and physical properties to a growing number of emerging technologies like wind turbines, solar energy collectors, electric cars and other applications (both civilian and defence). The above list of Technology Metals and ECEs are not definitive, but will change overtime as technology and other factors evolve.

Many of these potential elements are not found in concentrations high enough to warrant extraction as a primary product, instead are obtained as byproducts during the refining of base metals. . For example, the base metal zinc is our only source in the world of germanium, cadmium and indium metals. The base metal copper is a source of 75% of the world's molybdenum and rhenium. Copper is also the source of 95% of the world's tellurium and selenium; and the base metal aluminum is the only source of the metal gallium.

Technology Metals: Molybdenum (Mo), Rhenium (Re), Tellurium (Te), Selenium (Se), Germanium (Ge), Cadmium (Cd), Indium (In), Gallium (Ga), Vanadium(V), Scandium (Sc).

There are nearly 10 important minor metals (listed above) used in many applications which have impacted our lives in a big way. Their availability is critically linked to production of primary base metals like Cu, Al, Pb/Zn and their extraction in the primary circuit itself. They are used in very small quantities but when multiplied by large volumes of ultimate products, they become strategically important. The applications range from aircraft engines, motors and domestic appliances, automobiles, cell phones and computers, ubiquitous energy devices thus serving a large consumer base. There are twin qualities in the application of these minor metals. Their production is technology intensive and the dispersion (large entropy production in its life cycle) in the final products over make their retrieval and recycling difficult though possible with strong regulations. Till date it is very minimal.

Molybdenum, Rhenium (nearly 75% of world's production) , Tellurium and Selenium (95% of world's production) come from copper mines and they are by products of copper concentrators and smelting plants. Rakha mines of HCL had a pilot plant to produce moly concentrate and it has been closed for over a decade. Te and Se are extracted to a limited extent by HCL. It is important to note that there are no primary sources for these metals and even in the case of moly, three fourths of production is from the copper circuit. Special steels to next generation semi conductors are based on molybdenum and it is now being treated as a technology metal rather than a mere alloying additive to make strong steels.

The picture becomes serious, when we consider Ge, Cd and In which come from the Zn primary circuit. These metals (along with Se and Te coming from Copper circuit) form the backbone of thin film electronics industry with applications in computers, TV displays to cell phones, energy devices and innumerable PCBs. Indium is becoming is scarce thanks to its application in display systems in millions of TV and computer screens so much so that the next generation solar cells which now use In are to be made "indium free" to render solar PV cost effective. Bayer liquor in aluminium extraction process is the only source for gallium metal which together with arsenic (Gallium arsenide) is an important semiconductor which occupies the second place immediately next only to silicon in terms of depth and breadth of applications. Vanadium occurs both as primary and as secondary source, it is found in significant quantities in Bayer liquor. Presently it is taken out as sludge and disposed off to scrap traders. India being one of the largest producers of alumina and aluminium, it is but logical that a multi metal extraction strategy would have made India the largest producer of Ga and V as well. Scandium is one of the costliest metals that has important applications as alloying element and as additive to other rare earth oxides used in energy devices and electronic goods. Scandium generally occurs along with tin deposits and till date efforts to identify Sc in Sn sources and presence of Sc in Sn slag that is disposed off at low prices are to be intensified. The places of processing Sn slag might be away from Sn smelters as slag is disposed off to scarp traders. It is an urgent need to study the Sn minerals and Sn slag for occurrence of Scandium.

Energy Critical Elements (ECEs):

The Energy Critical Elements (ECEs) include gallium (Ga), germanium (Ge), selenium (Se), indium (In), and tellurium (Te). The main application of gallium is in solar cells, hydrogen generation and is a byproduct of Al and Zn processing. Germanium finds its application in Ga- Arsenide Solar cells, and fiber optics and is a byproduct of Zn, Cu, Pb refining. Selenium is used in solar cells and is a byproduct of Cu refining. Similarly Indium is applicable in LED, Solar cells and Battery and is a byproduct of Zn, Cu, Tin refining. And tellurium is applicable in Solar panels (Cd-Te), and thermoelectric applications and is a byproduct of Cu refining.

Issues:

The supplies of some of these elements are insecure due to geological scarcity, extraction difficulties and dependence on sources in politically volatile countries. Their risk of supply shortage affects the programmes of futuristic high tech applications especially in clean technologies, defense etc and their impacts on economy are higher compared to most other raw materials. We need to recognize that this is an issue that affects broad range of technologies.

There are two reasons for these critical elements to become scarce. Some, like tellurium, are simply not that abundant anywhere in the earth's crust, whereas others are found only in a few places, which might create political issues for their supply. China's dominance over Rare Earth Elements falls into that category, or Bolivia's and Chile's vast resources of lithium, which is used for rechargeable batteries. And the known global reserves of niobium, which is abundant and used for steels and other alloys, are almost entirely located in Brazil.

Moreover, ECEs have not been a primary target of domestic mineral exploration in the past, so there is limited knowledge of what geological characteristics indicate the likelihood of ECE deposits. There is an urgent need for a thrust for cooperative research in geological modeling of the mineral deposits, ore forming systems, basic geochemistry and extraction and processing technologies of these elements. This also calls for developing multi metal extraction strategies in the present primary metal circuits and a thrust in R&D to develop beneficiations flow sheets for purifications and process technologies of these elements.

Keeping this in view and increasing demand of these metal s for high tech applications, Ministry of Mines has stressed the need to incentivize exploration & process R&D for creating indigenous production capacities. The Centre is undertaking a collaborative study with Non Ferrous Technology Development Centre (NFTDC) Hyderabad and Centre for Study of Science Technology and Policy (C–STEP) Bangalore in this direction.