



Sustainable development and the chemical elements

Chemical elements from the perspective of the Sustainable Development Goals

Discussion Forum Concept Paper

This document has been expanded somewhat since March 2019 to cover the Sustainable Development Goals (SDGs) as well as the IYPT.

Background

The General Assembly of the United Nations (UN) proclaimed 2019 the [International Year of the Periodic Table of Chemical Elements](#) (IYPT2019) in December 2017, during its 72nd session. Thereby the UN has recognised the importance of raising global awareness of chemistry and how it can promote solutions to global challenges in energy, agriculture, health and other critical sectors.

The [United Nations Educational, Scientific and Cultural Organization](#) (UNESCO) announced the IYPT2019 in March 2018. The [announcement](#) said: “The Periodic Table of Chemical Elements is more than just a guide or catalogue of the entire known atoms in the universe; it is essentially a window on the universe, helping to expand our understanding of the world around us.”

The periodic table is regarded as one of the most important achievements of modern science, conceptually uniting various scientific disciplines.

Leading scientific centres across the world supported the proclamation of IYPT2019. They include:

- the International Union of Pure and Applied Chemistry (IUPAC)
- International Union of Pure and Applied Physics (IUPAP)
- the European Association for Chemical and Molecular Sciences
- the International Council for Science (ICSU)
- the International Astronomical Union (IAU)
- Joint Institute for Nuclear Research (JINR)
- the International Union of History and Philosophy of Science and Technology (IUHPST)

Other stakeholders are expected to be brought together “including scientific societies and unions, educational and research institutions, technology platforms, non-profit organisations and private sector partners to promote and celebrate the significance of the IYPT2019 and its applications to society during 2019.”

Fairly recently four super heavy elements have been discovered namely: with atomic numbers 113 (Nihonium), 115 (Moskovi), 117 (Tennesin) and 118 (Oganesson).

The year 2019 is significant because it marks various significant anniversaries, e.g.

- the discovery of phosphorus 350 years ago by the alchemist Hennig Brand
- The grouping of 33 elements into gases, metals, non-metals and earths, in 1789, by Antoine Lavoisier
- Next year is the 190th anniversary of Johann Wolfgang Döbereiner's work on "triads"
- The discovery of francium in 1939 by Marguerite Perey
- The 100th anniversary of the founding of IUPAC – which along with IUPAP confirms the discovery of new elements and gives them their official names

The IYPT2019 will be used by UNESCO's [International Basic Sciences Programme](#) to promote international co-operation in the basic sciences for sustainable development. A UNESCO [Global Microscience Experiments Project](#) will also be dedicated to the periodic table. Microscience is an educational initiative that provides low-cost experimental equipment to primary and secondary school pupils – and university students in some countries.

Focus and scope of the NSTF discussion forums

To narrow down the wealth of possible topics and information related to the periodic table, a selection of topics that are relevant to society and the economy had to be made. The National Science and Technology Forum (NSTF) is providing a platform to discuss the following topics on three occasions (18 March, 19 March and 16 May) through NSTF Discussion Forums:

1. **18 March 2019: Rare earth elements and their use in 4th Industrial Revolution (4IR) technologies.** What elements might be in demand now and in the future for use in 4IR technologies? Does South Africa have significant deposits of such minerals? Might it be feasible to extract these minerals, now or in the future? Among the critical problems that South Africa is facing is the (perceived) demise of mining as a reliable economic sector, in the context of the 4IR. Further job losses are inevitable and there is a scramble to catch up with the technologies and opportunities offered by this new era. At the same time, South Africa is a country blessed with substantial mineral resources. It is generally recognised that these resources have to be beneficiated and not just exported to other countries. Creating products and industrialisation are the key to our economic future. Electronic hardware contains small amounts of a variety of metals as essential components. As the industry continues to grow at an exponential pace, and 4IR technologies all rely on electronics, it is anticipated that these metals will be in ever higher demand and become increasingly hard to access.
2. **19 March 2019: Managing elements for human health and safety.** What are the issues related to essential minerals in human nutrition? Where and how do people in South Africa suffer nutritional deficiency in terms of minerals in their diets? What are the issues related to minerals for crop production? What are the issues related to the safety of substances people inadvertently come into contact with? Some elements are now known to be fatally harmful. It appears that much is known about the essential minerals required by the human body, the exact quantities of these that ensure good health and the food sources that can supply us with these minerals. However, there is much public confusion about these matters. While the moneyed classes debate the merits of products that are supposed to provide exceptional health benefits, the poor eat whatever food they can get and are more likely to suffer major nutritional deficiencies.

3. 16 May 2019: The elements in relation to the Sustainable Development Goals (SDGs)

This discussion forum is sponsored by Department of Science and Technology (DST) Multinational Relations, as one of several activities throughout the year, to celebrate the International Year of the Periodic Table. The SDGs are of critical importance to developing countries, to Africa as a whole, and Southern Africa. Stats SA monitors our progress in terms of the SDGs as a country, and the Department of Planning, Monitoring and Evaluation (DPME) reports on such progress, and has the task of ensuring that planning is done with the aim of meeting the SDGs. UNESCO provides a modest amount of funding to governments to promote and effect its initiatives, such as the SDGs and the UN International Years, including of course the IYPT.

In relating these disparate topics, we have matched some of the most important SDGs to issues related to selected chemical elements.

The SDGs

See the UN's [sustainable development website](#) for the lists of targets under each goal.



The following 8 SDGs were selected from the 17:

Goal 1: No poverty

Goal 2: Zero hunger

Goal 3: Good health and well-being

Goal 4: Quality education

Goal 6: Clean water and sanitation

Goal 7: Affordable and clean energy

Goal 8: Decent work and Economic growth
Goal 9: Industry, innovation and infrastructure

Speakers are asked to relate their expert knowledge of the elements to one of these SDGs.

NSTF Discussion Forums that have addressed related topics:

- [How can research and innovation in publicly funded institutions support the sustainable development goals](#), 4-5 September 2017 – initiated by the representatives of Science Councils and Statutory Bodies sector of the NSTF
- [The Water-Energy-Food \(WEF\) Nexus](#) (Here WEF stands for Water, Energy and Food), 23-24 October 2018 – initiated by the representatives of the NSTF Science Councils and Statutory Bodies sector
- [Chemical elements for South Africa's Future #IYPT](#), 18-19 March 2019

The [outcomes](#) of the previous discussion forum on the SDGs are on the NSTF website.

Particular points from the media release are relevant now:

South Africa will be reporting on SDG progress in 2019 and it's imperative that the science, engineering and technology (SET) community understands its role.
SA baseline measurements: There are 230 indicators/measurements specified under the SDGs, as well as 169 targets.

In his presentation, Statistician-General Pali Lehohla noted that the South African SDG baseline report was about to be published.

Coordinating role of DST: The DST's Dr Isayvani Naicker says that the DST has a role to play across all the SDGs, particularly around enabling partnerships. This falls in line with the DST mission to develop, coordinate and manage a National System of Innovation. Coordination becomes crucial – What are people doing? Where is the duplication? How can resources be mobilised into the most needed areas?

SET is seen as enablers for the SDGs: The Presidency is charged with collating and reporting. To reach that point, there is a need for monitoring and evaluation across government departments, business, civil society etc. SET is recognised as an enabler in the successful implementation of the SDGs, and will also help in monitoring and evaluation.

The CSIR's research to date shows five key clusters of actors needed to achieve the SDGs– United Nations (governance and support from an international perspective), government (enabling and monitoring environment), business (implementation), research and development (knowledge, technologies and innovation), and civil society (advocacy and awareness).

Envisaged outcomes:

- Materials on the NSTF website: presentations, videos, proceedings, media release, etc.
- A list of issues raised by speakers over the 3 days (in March and May) – including issues in relation to the SDG's, the mining and beneficiation of rare earth metals, essential minerals for human health and related issues of nutrition and safety.

Target audience:

These discussion forums should be of interest to a wide range of people who want to see the connections between sectors, and various developmental issues, while touching on some technical facts surrounding the elements of the periodic table.

For the discussion forum on Elements for South Africa's future and the SDGs, the following is the target audience:

- **Policy makers** in energy, water, food, health, education, mining, industrial development, agriculture, etc
- **Researchers** in energy, water, food, health, and education (For the previous events: the audience included those interested in research in mineralogy, information technology, electronic engineering, food security, nutrition, etc)
- **Engineers** in all branches, **science educators**, people involved in the **industries** – (For the previous events: industries included agri-processing, mining, IT hardware professionals, nutritionists, producers of health supplements and traditional medicine products)
- **All those interested** in sustainable development and science

Sources and further reading

About the Year of the Periodic Table:

<https://en.unesco.org/news/2019-proclaimed-international-year-periodic-table-chemical-elements>

<http://www.unesco.org/new/en/unesco-liaison-office-in-new-york/about-this-office/single-view/news/2019-international-year-of-the-periodic-table-of-chemical-el/>

<https://physicsworld.com/a/chemists-gear-up-for-2019-international-year-of-the-periodic-table/>

Elements essential for human health, as well as elements that are harmful to human health

<https://www.netdoctor.co.uk/healthy-eating/a10839/sources-of-minerals/>

<https://www.thyroid.org/iodine-deficiency/>

<https://www.nda.agric.za/docs/media/NATIONAL%20POLICYon%20food%20and%20nutrition%20security.pdf>

<https://www.mining-technology.com/features/featurethe-11-most-dangerous-minerals-4256873/>

https://en.wikipedia.org/wiki/Lead_paint