Journal Comment

The great conundrum

The world is currently going through two major events simultaneously, in a once-in-a-lifetime or 100-year experience: a major pandemic and, as a longer-term cycle, climate change. In reading between the lines, neither has been solved to a satisfactory conclusion and neither are likely to be solved any time soon.

Of specific interest to the mineral, mining and metallurgical industries in the world is the climate change issue. This is where the great divide comes in – firstly, climate scientists and numerous environmental lobbyists projecting that the world is nearing extinction, disaster, more catastrophic weather patterns, and the demise of hundreds of thousands of people, as well as numerous low-lying islands due to projected sea level rise.

This is counterbalanced by alternate views that offer other, less drastic scientific projections based on results drawn from past facts, current experience and other carefully drawn calculations showing far lower points of concern, and setting the world's climate and weather patterns into a more modest and cyclical pattern over a far longer timespan. Such views are often not permitted to be published in the open media.

In essence, both parties claim REALITY, one on the basis of unknown and as yet **unproven future values** as predicted by predicted equations, and the other based on **past experience over millennia**, and more modest, currently experienced views. The history of global emissions is summarized as follows.

At the beginning of the 20th century, smoke pouring out of a chimney was a sign of progress, prosperity and job creation. However, the problems of poor air quality, as early as the end of the 16th century, are well documented. By the middle of the 20th century, air pollution was recognised as a serious problem. For example, the London smog of 1952 resulted in approximately 4000 extra deaths in the city, leading to the introduction of the Clean Air Acts of 1956 and 1968.

Factories and households were subject to smoke emission limitations because of health, safety and environmental reasons. On the other hand, the de-smoking was accompanied by capital and operating costs.

The de-smoking process has always had a negative impact on the 'bottom line' of industrial operations, being an expense that did not earn income but was an essential condition for an operating licence. However, the internalization of external impacts greatly increased the quality of life. The limiting of other pollutants quickly followed, for example de-SOx and de-NOx. Each had its accompanying costs. The limitations of emissions of such pollutants are controlled by regulation.

In a similar vein more recently, the mitigation of greenhouse gas emissions is being addressed as a measure to address global climate change. Such de-carbonization is also accompanied by a cost. The difference between de-smoke, de-SOx and de-NOx and de-carbonization is that the first three are local/regional impacts whereas de-carbonization is considered to be of global concern.

The mitigation of greenhouse gas emissions is therefore now a global matter. For instance, if South Africa alone were to stop using fossil fuels tomorrow, such action would have no noticeable impact on global climate change, but would impact our gross domestic product. However, as de-carbonization is a global action matter, South Africa is obliged to implement such measures in concert with the rest of the world.

But South Africa, and likewise other developing countries, need to balance socio-economic and industrial development with environmental matters. There are five main options to de-carbonise energy that are being undertaken internationally, namely:

➢ *Fuel Switching*—Switching from high carbon fuels to low carbon fuels leads to lower carbon dioxide emissions. For example, switching from coal to natural gas for electricity generation has been calculated to decrease carbon dioxide emissions by approximately 50%. However, questions arise as to the validity of this calculation. In the case of South Africa, natural gas is in any case scarce, and politically controlled by neighbouring countries, if available at all. The Hydrogen Economy has its own problems as water is required, as well as high levels of power in the manufacture of hydrogen – of which the scarcity of inland water is the most limiting.

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- *Energy Efficiency*— It is commonsense to use less energy and achieve the same output, thereby lowering energy costs. An example is the swapping of incandescent light bulbs (typically <5% efficient) with a more efficient form of lighting such as a compact fluorescent light bulb (typically 85% efficient) or a light emitting diode (LED) (typically 90% efficient).
- *Renewable Energy*—Renewable energy emits very little carbon dioxide during operation. However, carbon dioxide is emitted during the manufacture of the iron, steel, glass and cement required for construction, and during the mining required to obtain the components for such manufacture. Furthermore, renewable plants have a life span of only 15 to 20 years (*versus* a coal-fired plant of 60 years), and solar panels and wind turbine blades are problematic in their end-of-life discarding, as such materials contain hazardous and dangerous trace elements. The density of renewables is of the order of one part fossil fuel power to 4 to 6 power units from renewable power, each of which require space, and reliable expensive batteries or alternate backup power-generating sources. It is of interest to note that the lack of power during COP26 meetings resulted from low wind and solar power in the UK during that period, and local power conventional power stations were called on to supply the necessary electricity during that period.
- *Nuclear*—Nuclear emits very little carbon dioxide during operation. However, carbon dioxide is emitted during the manufacture of the iron, steel and cement required for nuclear power plant construction, and from the mining required to obtain both uranium and the components for such plant manufacture. However, nuclear is the source most likely to supply energy in the future once fission has been developed to its required control levels.
- *Carbon Capture Utilization and Storage*—This involves capturing the carbon dioxide before it is released into the atmosphere and storing it in an appropriately deep geological formation. It is also possible to utilize carbon dioxide to create higher energy products, using renewable energy.

The most notable use of carbon dioxide is for enhanced oil recovery, where approximately 50% of the injected carbon dioxide remains in the geological formation. South Africa has no oil deposits where this technology can be used. However, recent research has shown that CO_2 from Eskom-equivalent flue gases can be used to manufacture valuable carbon materials, including carbon nanotubes, carbon fibre, and activated carbon. Other greenhouse gases are also now able to be utilized for the manufacture of a host of other valuable commodities, including fertilizers and sulphuric acid for the mining industry. It is worth noting that Sasol, in gasifying coal, supplies one third of South Africa's liquid fuels including petrol, and many dozens of chemicals, paint, plastics, explosives, pharmaceuticals and cloth, and a vast array of other industrial materials and chemicals. Coal and its related sediments are also valuable sources of rare earth elements.

Of particular interest to coal-rich countries is the example of the clean coal technologies, of which the Turk Power Station in the USA is one such example. This coal-fired power plant has been running for some time in the USA and it produces 99.9% clean air – *i.e.* NO emissions at all. This example mirrors many plants now operating or currently being installed in the Far East.

Each of these options has a different maturity profile, as well as varying associated costs. Once emission limitations are imposed it would be up to each person, company or country to determine which technology is appropriate for that person or body's use. But the question needs to be asked – why not consider the alternate view and use such emissions at great benefit to the country until the maturing of safe and reliable energy sources (fission?) are developed in the medium to longer term?

The important role of coal in South Africa's power generation and manufacturing economy is evident. Its role can be expected to continue for many years as the country moves to meet its environmental commitments. It is important to understand this resource and its use so that it can be utilized in the most effective, responsible and efficient manner.

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