



## A mineralogical phoenix rising out of the ashes ...?



In the last two centuries there have been significant changes in the way energy is generated. In countries that lack other natural resources such as hydropower, energy has traditionally been derived from solid, liquid, or gaseous fossil fuels. A mix of factors, including geological resources and technological advances, as well as political and economic pressures, has led to the selection of energy sources in each country. Over time, energy selection has been influenced by the availability of resources, the cost of production, and more recently by environmental impact.

In almost all of the world's major industrialized nations, coal has been the primary source of power generation and a significant contributor to economic growth. But with the evolution of today's complex energy mixes, the role of coal and its sister fossil fuels (oil and gas) is gradually changing. In the past two decades, the percentage of global energy produced from coal has decreased from 87% to 84%. Coal's continued economic importance is due to its abundance, low cost, wide applications, and security of supply. The future role of coal will depend on a combination of factors, including mining pollution and the emission of CO<sub>2</sub> and other greenhouse gases from coal-fired power generation. It is believed that these emissions have contributed to global warming and climate change, resulting in severe pressures from political and environmental quarters.

In recognition of its value in supplying safe, secure, and reliable energy, coal now needs to be used in a variety of clean coal processes as the world moves towards its Just Energy Transition. This approach has been taken widely by China and other countries in the Far East. No doubt South Africa will follow suit in due course.

However, the value of coal is now being recognized for a very different purpose. Coal is considered as an important source of carbon, rare earth elements, and related mineral-based commodities which are vital components in all high-tech, high-value advanced materials of the future. These include a range of products vital for use in the manufacture of renewable energy equipment.

This awakening to the new and alternative value of coal began in the USA and is now spreading globally, to the extent that coal is now regarded by some international bodies as one of the most valuable mineral commodities available. For these reasons, coal is now being termed in some quarters as 'carbon ore' and regional centres manufacturing high-tech high-value carbon-based products as 'carbon valleys', the equivalent of Silicon Valley in the USA.

Against this background, South Africa is now at an important crossroad.

On one hand, the country is undergoing a significant energy transition from coal to other sources of energy due to its commitments to meeting net-zero carbon emissions in the near future. On the other hand, a further and more innovative opportunity is now opening up for the use of coal in a highly efficient, responsible, and far more economically and nationally significant manner.

This new approach embraces a new coal-carbon value chain which, if followed, would lead to the development of new industries, increased employment opportunities, and the production of innovative products of considerable value in the fast-evolving world of modern construction, transport, and aerospace applications.

Such an approach would entail the recognition of coal as a high-value 'carbon source' yielding products of much greater value than simply producing a megawatt of heat or power that is gone in a flash. Furthermore, the use of carbon for production purposes would meet South Africa's goal of capturing and use of carbon to achieve a low-carbon economy.

## Journal Comment *(continued)*

The US Department of Energy (DOE) has predicted that over the next 25 years, industries that manufacture coal-to-carbon products in coal mining communities could generate 280 000 to 480 000 jobs using low-skilled to highly skilled artisans. The DOE predicts that the global market for advanced carbon-based materials and products will reach over \$96 billion this year. To give an example, Dialead carbon fibres from Mitsubishi Chemical Carbon Fiber and Composites USA are produced from a high-performance coal-tar pitch. The carbon fibre is being used to manufacture aircraft structural components, pressure vessels, wind turbine blades, and various items of sporting equipment, among other products.

With such expansion in this field, the American National Coal Council estimates that the tonnage of coal used in product manufacture has the potential to equal that utilized for power generation in coming years. In South Africa, a further benefit would be the dual use for coal being mined, namely full use of both the better grades for export, Eskom, or industry, and full use of lower grades for carbon-based products. The sources of the latter materials include coal fines, discards, coal tar pitch, and low-grade run-of-mine coal. Such precursors are the low-cost throw-away/discarded products of coal mining, and their use would also thereby serve the country's interests in the circular economy as it applies to coal mining.

The forms of advanced carbon materials for which South African coals can be used include carbon fibre, carbon foam, graphene, carbon nanotubes, activated carbon, and coal composites. The expectation is that these will replace or complement conventional materials in the production of aerospace and electric vehicles, as well as in robotics and energy storage. In the latter scenario, carbon products will enhance the capacity and performance of lithium-ion batteries and be utilized to securely store and transport hydrogen in various forms.

At the University of the Witwatersrand and elsewhere, research and development is currently underway to establish South African coals as the source for advanced high-value products. This requires collaboration between all stakeholders (government, industry, research institutes, and others) to support this endeavour in order for the industry to reach its full potential. If successful, in due course South Africa could be the 'Carbon Valley of Southern Africa'.

In these ways, the often-denigrated mineral called coal could become the bright and shining *Phoenix* of the mineral industry, literally *rising out of the ashes*.

S.O. Bada