Energy = the ability to do work

In the world of physics, energy is often defined as the ability to do work.

Energy can be found in a number of different forms - be it chemical, electrical, heat (thermal energy), light (radiant energy), mechanical energy or nuclear.

Energy, in all its varied forms, is an essential part of every aspect of life. It is the foundation for the economy and lifestyles. What would happen if that foundation crumbled? If the lights went out and the computers went dead and there was no fuel for cars or trucks or planes?

In a recent publication, Paul Chefurka, gives a disturbing view of the future of energy in his article on *World Energy to 2050: A Half Century of Decline*.

The article offers a comprehensive look at the world's evolving energy picture and confines its projections to the first half of the century. As one highly probable effect, Chefurka concludes that the decline in total energy would have a profound impact on the quality of human life. "How many ways are there to say the world is heading for hard times? Losing most of our oil is bad enough, and losing most of our gas as well, borders on the catastrophic. Combining these losses with the exponential growth of those nations that can least afford it, is nothing short of cataclysmic. The ramifications spread out like ripples on a pond. There will be 7 billion people who will need fertiliser and irrigation water to survive, but would be too poor to buy it even at today's prices. Given the probable escalation in the costs of fertiliser and the diesel fuel or electricity for their water pumps, it isn't hard to understand why the spread of famine in energy-poor regions of the world seems virtually inevitable."

The article maintains that the answer to this picture of gloom may lie in sustainability, cooperation and nurturing, and in finding new ways of living that will be required in future. The CSIR - through its energy and processes area - has already adopted the author's proposed approach and is well established in realising its aim to develop globally competitive, sustainable and environmentally acceptable energy processes and technologies for the processing and manufacturing industries. This particularly applies to the chemical and allied, and minerals industries, in line with the national goals towards achieving cleaner energy technologies and focusing on renewable resources. Research and development (R&D) of next-generation energy conversion technologies, specifically directed at materials science and chemistry in order to improve performance and reduce costs, is undertaken.

The group is partnered by the South African National Energy Initiative (SANERI) to shape R&D in this area.

Several research groups focus on hydrogen economy and fuel cells, hydrogen storage, low-smoke fuel and appliance testing and fluidised bed (FB)-technology.

Facts of energy life

Every day we use about 80 million barrels of oil and 280 billion cubic feet of natural gas. That's what it takes to keep the world running, and by 2030, experts predict it will require about 50% more energy.

Billions of times every day - at the flip of a switch, turn of a key or push of a button - energy is instantly available. It moves people, material and products; it fuels commerce; it helps make products that are safer and stronger than at any time before in history.

Energy is essential for today's societies, so much so that it is often taken for granted. People simply expect it - and demand it - and that makes the job of supplying energy even more important.

In current research projects, the fabrication of membrane electrode assembly (MEA) for direct alcohol fuel cells (DAFC), H_2FC and direct methanol fuel cells (DMFC) are undertaken.

Experiments are conducted with different MEA architectures, including the electrocatalyst deposition on nafion membranes and the electrocatalyst deposition on the carbon cloth and carbon papers.

These studies aim to optimise the hot-pressing conditions and fabrication of three-layered MEAs. The MEAs are characterised for morphology using scanning electron microscope (SEM) and optical microscopy observations, structure with X-ray diffraction (XRD), resistivity by impedance spectroscopy (IS) and electrochemical active area by cyclic voltammetry. The ultimate aim of the project is to produce MEAs that give power outputs in the range of 5-100 W, that would be assembled into stacks of 500 W to 1 kW.

The group also conducts research into the nanocrystalline titanium dioxide (TiO_2) dye solar cells (DSC). The DSC operates as a regenerative photo electrochemical process similar to the photosynthesis in plants. The DSC allows for a more flexible use of materials and is manufactured by screen-printing, resulting in cost advantages over the more expensive manufacturing techniques used for traditional PV cells, and significantly less embodied energy. The eventual aim of this project is to produce stable nano-TiO_2 DSCs with comparable efficiencies to that of its inorganic counterparts at a reduced cost.

For the energy and processes group of the CSIR, a fitting motto would be: The future is ours, but we need energy to get there.