R&D and innovation in South Africa to meet energy challenges

By Mpho Makwana,
Chairman, Eskom Holdings

The energy challenges facing South Africa are diverse and range from achieving universal access to a high carbon intensity of the energy mix. The regional resources for the generation and operation of energy facilities are abundant but there are constraints on a geographical basis, for example variations in the availabilities of water and coal resources.

In general, technologies which are developed elsewhere are adopted in South Africa, but given the scale of the challenge and the particular set of energy resources in the region, there is a need for local technology development or adapting existing technologies for the region's specific needs and circumstances. There are also significant opportunities in the region to grow the energy access and availability in a cleaner and lower-carbon way and develop regional markets and local content supply chains for clean technologies. Eskom has a long and proud history of innovation. For example, dry cooling for power stations was pioneered and developed in South Africa, as was the use of high altitude, high voltage transmission line infrastructure. At one stage its electrification programme was the biggest and most effective in the world and Eskom's ability to burn low-energy coal is still leading edge.

Eskom still has an active programme of technological innovation which assists in making the decisions so vital to the future. In this regard Eskom is developing a number of innovative technologies that will improve the effectiveness of current operations, and provide the business with new, more attractive options for the future. Firstly, Eskom is considering at how to improve the way coal is used in power stations. This includes technologies which reduce erosion in boilers, welding technologies to reduce outage times for repairs and live line maintenance techniques which enable the maintenance and repair of power lines without interrupting supply to customers.

However one of the biggest challenges facing South Africa is the large-scale technologies to use in the future. No longer can businesses base technology choices on simple operational or cost drivers. Investments need to be made in technologies which will maximise the social, economic and environmental returns for the business and society as a whole. This means ensuring that the technologies which will maximise these returns are mature and familiar when required. In this regard Eskom is undertaking a suite of exciting technology demonstration projects aimed at defining a different future for our business, society and environment. Some of these are described below.

Underground coal gasification

Southern Africa has extensive coal reserves. Underground Coal Gasification (UCG) is one of several advanced clean coal technologies being investigated by Eskom. UCG is a process where coal is gasified in situ. A matrix of boreholes is drilled into the coal seam, sealed wells are created, the coal is ignited and air is pumped into the injection wells. Fire is essentially used to "mine" the coal, and produce a gas which can be used directly as a fuel for power generation.

The UCG process avoids the need for coal mining, transportation, preparation, the gasifier equipment, and the transportation and disposal of ash. This optimisation has cost, labour and environmental benefits. UCG is also able to utilise the enormous local resources of coal that are regarded as 'unminable' by conventional miners. The use of UCG gas as a fuel for advanced clean coal technology power generation enables several key strategic drivers.

The Eskom pilot plant was commissioned in January 2007, and continues running successfully until present, delivering 15,000 Normal Cubic Metres per hour (Nm^3/hr) of gas, proving the technology and verifying performance for the phases to follow. The next phase of the demonstration is a 100-140MW open-cycle gas turbine. Stakeholder engagement and a full environmental impact assessment (EIA) are already underway. The plant will be able to prove and quantify the technical, environmental and commercial performance of the technology, and will be able to predict design and performance of a full-scale, commercial UCG plant. In parallel to the demonstration plant design, the pilot plant is presently ramping up gas production, in order to prove the concept of co-firing the UCG gas with coal in Majuba power station's unit 4 – a 600MW unit in a 3,600MW power station. The interconnecting pipe work between the power station and the UCG gas field has been installed, and will be commissioned as soon as unit 4 is scheduled for an outage. The pilot plant is gaining incredible interest locally and globally given the technology's potential for clean and lower cost electricity production.

Utility Load Manager

In South Africa, the reserve margin will be low over the next few years and will only improve after new baseload coal plants come on line. The country therefore needs to put in place measures to decrease the demand by effective demand management measures. The Utility Load Manager (ULM) is an innovative device that has been developed entirely in South

Africa jointly by Eskom and EON Consulting. The ULM was principally developed as a total solution to assist in alleviating generation capacity, network and system constraints by limiting the residential sectors load and averting any future load shed conditions. The systems control methodology is patented locally and is regarded as a world first. A global patent application has also been awarded.

The ULM system is designed to operate as a Virtual Power Station (a stand-alone fully integrated system) and is a real time, residential load management system that allows the utility to limit residential loads as opposed to block load shedding. The residential sector represents 17-20 per cent of the total system load and is a significant contributor to both the morning and evening peaks resulting in an overall national load factor of 72 per cent. The ULM targets the residential sector by actively engaging the customer and installing a system of hardware devices in the LV network. When the power utility has a supply or network constraint, a message can be sent to the display unit, instructing the household user to limit their power usage. If the household conforms to this limit, by switching off appliances and conforming to the required power limit imposed, the household will continue to get this limited power for the period/duration of the load limit period (the period whereby the supply/network constraint is experienced). However, if the household does not conform to this imposed load limit, and continues to exceed the limit in terms of power usage, that household will be automatically disconnected from the electrical network.

The ULM will be used as a tool to avert load shedding as mentioned above and once there is sufficient generating capacity to assist in managing revenue and energy streams with real time reconciliation of all parameters

Concentrated Solar Thermal (CSP)

CSP comprises a family of technologies that concentrate the sun's energy through large mirrors and utilises the concentrated thermal energy to produce steam to drive a conventional steam turbine for electricity generation. Eskom has focused on the "Central Receiver" or "Power Tower" type technology.

Eskom has actively participated on the international CSP stage since 1999, when it joined the International Energy Agency's programme on solar power. Initial efforts were directed at assessing the various CSP technologies and at identifying the option most promising for application. The World Bank's approval in April 2010 for a US$3,75 billion loan to help South Africa achieve a reliable electricity supply includes financing for a CSP pilot plant and the planned wind power plant along the west coast of South Africa.

Conclusion

Africa is populated by over 700 million people who constitute approximately 12 per cent of the global population, but consumes only 2 per cent of all electricity produced globally. Almost all of Africa's diverse and abundant fossil and renewable energy resources are under-utilised due to economic, technical and environmental constraints. The opportunity exists for innovative technologies to be explored, to ensure sustainable development and growth for the continent.

Eskom's innovation and demonstration programme supports the infrastructure expansion programme through research that improves quality, reduces cost and reduces the time taken from conception to commission. It also drives and challenges our capital expansion technology – choices based on the knowledge gained through demonstration – by ensuring that key technologies that can fundamentally change Eskom's current technology path and improve performance are well understood and part of our technology plan. The programme has also been focused on technologies that optimise the use of our natural resources and reduces our carbon footprint. ❑

Eskom remains a pioneer in Africa's energy sector