**Renewable Energy Focus**

# Long-term electricity sector expansion planning outcomes: A unique opportunity for a least cost energy transition in South Africa

Wright, Jarrad G
Council for Scientific and Industrial Research
Pretoria, 0001, South Africa
Email: JWright@csir.co.za

## Abstract

With climate change being near unequivocally linked to anthropogenic greenhouse gas (GHG) emissions (particularly CO2) there is an ongoing global move to decarbonise economies with the electricity sector being the predominant focus of most countries' strategies to slow down and reduce CO2 emissions. In the context of South Africa, this research presents a Business-as-Usual scenario and electricity sector capacity expansion plans to determine a Least-Cost as well as Decarbonised electricity mix (95% CO2 reduction by 2050 compared to expected 2020 CO2 emissions). A significant finding is that South Africa has the unique opportunity to transition from an existing CO2 and water intensive coal-based electricity system to a low CO2 and low water intensity electricity system in the long-term at least cost. The approach taken is a generation capacity expansion optimisation using a mixed-integer linear programming (MILP) approach to co-optimise energy and reserves following which unit-commitment and economic dispatch models are run to assess system adequacy and better understand the expected energy mix. Solar photovoltaics (PV) and wind profiles are derived from already developed detailed datasets for South Africa and aggregated accordingly. The research finds that it is least cost for any new generation capacity investment to be solar photovoltaics (PV), wind or flexible capacity as a >75% renewable energy (RE) share by 2050 is cost optimal, replacing all existing generators that decommission and meeting new demand. By 2050, the Least-Cost scenario is conservatively ~$ 5.1-bln/year cheaper than Business-as-Usual (~12%) and ~$ 7.8-bln/year cheaper (~20%) when applying expected cost assumptions for solar PV and wind. The Decarbonised scenario using conservative cost assumptions has a >90% RE share by 2050 also dominated by solar PV and wind complemented by flexibility. It is ~$ 4.8-bln/year more expensive to have this 95% decarbonised electricity system relative to the Least-Cost where an ~60% decarbonised electricity system is possible by 2050. Business-as-Usual as well as Decarbonised scenarios have similar costs when applying conservative cost assumptions but the

Decarbonised scenario becomes ~$ 4.8-bln/year cheaper than Business-as-Usual (~11%) when applying expected cost assumptions. This is while being 95% decarbonised relative to Business-as-Usual (at only 20% decarbonised by 2050 compared to expected 2020 CO2 emissions levels).