COUNTRY HIGHLIGHT

# South Africa – Coal Out, Solar and Wind In

***South Africa is demonstrating its commitment to a more sustainable future growth path by supporting renewable energy and energy efficiency measures, together with skills development and job creation through fostering a green economy. South Africa is among the highest emitters of carbon dioxide in the world, currently ranked in the top 20 in terms of top emitters per capita, since more than 75% of our primary energy requirement is derived from fossil fuels. The country responded to the urgent need to reduce fossil fuel dependency, diversify the energy mix and supply, and reduce the country's carbon footprint with a supportive policy and legislative framework that exploits the excellent local renewable energy resources, especially wind and solar.***

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South Africa's renewable energy sector experienced explosive growth in the past 10 years. The renewable capacity in South Africa is forecast to grow by 40% from 8 GW in 2017 to nearly 12 GW in 2023. Solar PV is leading this renewable expansion accounting for almost half of all the additions (1.6 GW) followed closely by onshore wind (1.4 GW), CSP (0.4 GW) and bioenergy (0.2 GW). Growth is being driven by competitive auctions under the Renewable Energy Independent Power Producer Procurement Program (REIPPPP) for utility-scale projects while distributed solar PV see growth from net-metering programs and self-consumption projects. Faster growth is limited due to uncertainties over the speed of the future auction rounds.

Recent developments over the past two years signal an increase in momentum for renewable deployment in South Africa, yet grid constraints and policy uncertainty remain key forecast challenges. Through the support of the new South African administration, Power Purchase Agreements (PPAs) were signed for 2.3 GW of installed capacity awarded under REIPPPP rounds 3.5, 4 and 4.5 in April 2018 after three years of delay. Shortly after these developments, the government announced plans to hold round 5 for another 1.8 GW. While these are seen as positive steps towards maintaining investor confidence, grid constraints remain a key challenge to future deployment.

The contribution of a green economy to economic growth and job creation is promising, and South Africa is preparing to play a leading role in renewable energy deployment. South Africa has abundant natural resources that can be harnessed for energy production. It boasts one of the best solar regimes in the world, measured at 4.5 to 6.6 $kWh/m^2$, one of the most abundant renewable energy resources in the country (1,900-2,200kWh per annum solar yield).

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Utilizing South Africa's solar resource for direct solar thermal energy production is one of the most resource efficient means of approaching renewable energy system integration. An electrical grid is not required to achieve this, and REN21 maintains that approximately 50% of the energy requirement is for heating; this makes solar thermal the most suitable technology for large scale implementation. South Africa has already begun to invest in this market development and harness this resource. This is evident from the solar heating average annual growth rate in technology deployment between 2010-2015 was only 6%, however within the year of 2015, it boosted to 12%, and it has continued to increase. This indicates significant market support to the technology being deployed nationally. In summary, renewables are gaining a proportionally larger share of the heat market, with the market size likely to be stable.

▲ **Figure 1. District heating system on the Wits Junction residence building combines solar thermal, co-generation and gas technologies**

There have been some significant developments in large scale solar thermal systems in South Africa over the past three years. On 15 May 2019, the Austrian Ambassador to South Africa, Dr. Johann Breiger, officially launched two major SOLTRAIN projects, the first solar district heating system and the largest solar process heat system in Sub-Saharan Africa. These are the first sub-Saharan district heating plant at the University of Witwatersrand in Johannesburg and solar process heat plant for the Klein Karoo tannery in Oudtshoorn, both of which will save millions in energy costs over the lifetime of the plants.

## SOLTRAIN

The Southern African Solar Thermal Training and Demonstration Initiative (SOLTRAIN) is a regional initiative on capacity building and demonstration of solar thermal systems in the Southern Africa Development Community (SADC) region. The program in South Africa is managed by the Centre for Renewable and Sustainable Energy Studies (CRSES) at Stellenbosch University and the South African National Energy Development Institute (SANEDI) in partnership with AEE - Institute for Sustainable Technologies (AEE INTEC) from Austria. It is funded by the Austrian Development Agency and co-funded by the OPEC Fund for International Development (OFID).

"SOLTRAIN is the most important and most successful know-how transfer project that AEE INTEC carries out worldwide," explains Mr. Werner Weiss, Director of AEE INTEC. "The two solar thermal systems launched in 2019 were built as part of SOLTRAIN and are the two largest solar thermal systems south of the Sahara. We are proud to have supported our South African partners to design and build them."

The success of the program has led to SOLTRAIN going into a fourth phase from July 2019 until December 2022. And Weiss adds, "We are already looking forward to the continued excellent cooperation with our South African partners and the joint implementation of many other demonstration projects."

With the widespread transition to solar thermal systems for hot water preparation in the residential, commercial and industrial sectors, the electricity sector in the SADC region could be massively relieved and, moreover, contribute to the reduction of $CO_2$ emissions since the vast majority of the region's power plants are run on coal.

The 326 solar thermal systems built to date in the SOLTRAIN program have a solar yield of 1,834 MWh/year and save about 2,000 MWh/year of electricity and avoid annually 638 tons of $CO_2$. If one kWh of electricity is valued at R0.21, the installed solar thermal systems save R4.3 million in electricity costs per year.

### *Wits Junction at the University of Witwatersrand*

The first of its kind, the Wits Junction district heating project, combines solar, co-generation and gas heating technologies, servicing 14 student residence buildings with hot water from one centralized hot water plant room. Installation includes a 600m$^2$ solar heating plant with 10m$^2$ Austrian collectors.

A combined system uses the advantages of each technology: solar has a very low running cost while CHP

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(combined heat and power) gives continuous baseload coverage. The combination covers thermal and essential electrical loads.

Over 1,100 students reside in 14 buildings, with an average consumption of 94,000 liters of hot water per day. Peak demand is in the morning, averaging 30% of daily consumption, with a maximum demand of 28,200 liters in an hour. The system supplies the entire hot water demand, including kitchens, laundry, cleaning and other domestic uses. Each student has his/her own kitchen and there are some centralized service rooms for cleaning staff.

Since the system was commissioned, the complaints of not having hot water have reduced by 98%. The redundancy design guarantees supply also during maintenance periods.

The estimated cost savings are R40 million over the next 20 years, and already the University has seen substantial electricity savings over the eight-month trial period. As the electricity cost from the co-generator is equal to municipal cost, the thermal energy is free and the centralized plant requires a lot less maintenance intervention, hence fewer costs. There is currently a backup water system installation in progress, with 300,000-liter tanks, and a more advanced logging and measurement system is also planned.

The system has been a major success in not only meeting financial and energy saving parameters, but also the service delivery levels have vastly improved. The small interruptions are from water interruptions from municipality or ring main circulation pumps blocked from debris in the water. Unlike previous systems, this project comes with integrated monitoring and maintenance from the very first planning day.

## *Klein Karoo Tannery*

The Klein Karroo International (KKI) tannery installed a 600m$^2$ solar collector system to reduce costs and increase competitiveness since fuel costs are highly volatile. There was also an underlying strategy to move its production to a more renewable base; however, finance was the main driver.

"Stellenbosch University approached various tanneries for process heat application viabilities and this tannery was the most forthcoming and had the budget to contribute to the study," says Mr. Doran Schoeman of E3 Energy.

The process heat infrastructure uses an oil burner and not electrical heating. The fuel source is LO10 paraffin oil, at an indicated rate of 11.8 kWh per liter. The feasibility study design was that the solar would displace the local fuel, indicated as 60% solar fraction. The estimated savings, based on measurements from the plant, are 285,000 kWh and an average of R265,000 over eight months or 24,150 liters of oil.

Stellenbosch University indicated a payback of 6.5 years based on a solar fraction of 60%. This is from a financial model analysis from the feasibility study, which includes maintenance, finance costs and all system-related expenses.

▲ **Figure 2. Ground mounted system at the Klein Karroo tannery.**

Strategically, the approach was to implement a first phase of renewable energy utilizing solar thermal and to monitor actual results to estimated savings. There has been no further commitment as yet, as the analysis is still in progress.

Dr. Karen Surridge, Centre Manager of Renewable Energy Centre of Research & Development at SANEDI concludes, "SANEDI is delighted to be associated with such landmark developments that put the SOLTRAIN projects firmly on the renewables table."

*This article was contributed by Dr. Karen Surridge and Ms. Khothasto Mpeqeke of SANEDI and Ms. Karin Kritzinger of the University of Stellenbosch.* For more information, go to https://soltrain.org