

# WORLD SMALL HYDROPOWER DEVELOPMENT REPORT 2013

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SOUTH AFRICA



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# 1 Africa

## 1.4 Southern Africa

### 1.4.3 South Africa

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#### Key facts

Population	48,810,427 <sup>1</sup>
Area	1,219,090 km <sup>2</sup>
Climate	Mostly semi-arid; subtropical along east coast; sunny days, cool nights <sup>1</sup>
Topography	Vast interior plateau rimmed by rugged hills and narrow coastal plain <sup>1</sup>
Rain Pattern	Mean annual rainfall of approximately 450 mm. Wide regional variation in annual rainfall, from <50 mm in the Richtersveld on the border with Namibia, to >3,000 mm in the mountains of the south western Cape. However, only 28% of the country receives more than 600 mm. Core of rainy season is December to February. <sup>2</sup>

#### Electricity sector overview

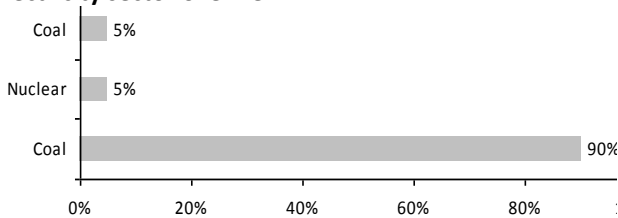


Figure 1 Electricity generation in South Africa

Source: Department of Energy<sup>3</sup>

Notes: Data from 2010.

South Africa has a total electricity generation capacity of about 45,000 MW. Nearly 90 per cent of electricity is generated in coal-fired power stations (figure 1). Koeberg, a large nuclear station near Cape Town, provides about five per cent of capacity, while the remaining five per cent is provided by hydropower and pumped storage schemes. Currently about 700 MW<sup>i</sup> of installed hydropower capacity exists in the country.<sup>3</sup>

Electricity generation is dominated by Eskom, the state-owned utility. Eskom also owns and operates the national electricity grid. It supplies about 95 per cent of South Africa's electricity and is one of the world's top seven energy producer in terms of generating capacity; one of the world's top nine in terms of sales, and it has one of the world's biggest dry-cooled power stations - Matimba Power Station (coal-fired; installed capacity 3,990 MW). South Africa, which for many years operated with overcapacity, has begun to experience a power crisis induced by rapid

growth in electricity demand, coupled with prolonged underinvestment in new generation capacity.<sup>4</sup>

Since the end of the apartheid rule, South Africa has gone from an overall 36 per cent electrification rate in 1993 to 80 per cent in 2007 and a further 81 per cent by 2012. Rural electrification, specifically, stands at 63 per cent.<sup>5</sup>

#### Small hydropower sector overview and potential

Currently no official small hydropower definition exists in South Africa, although the upper limit of 10 MW was used in the current renewable energy bidding process, de-facto limits small hydropower to 10 MW. Though not very well documented, small scale hydropower used to play an important role in the provision of energy to urban and rural areas of South Africa. The first provision of electricity to cities like Cape Town and Pretoria was based on small hydropower, while other smaller towns started local distribution of electricity through isolated grids powered by small hydropower stations. With the expansion of the national electricity grid and the increasingly cheap, coal-generated power supplied through it, a large number of such systems were decommissioned. A typical example is the Sabie Gorge hydropower station, with three 450-kW turbines, commissioned in 1928 to serve the town of Sabie in Mpumalanga and later closed in 1964, after the area was connected to the national Eskom grid.<sup>6</sup>

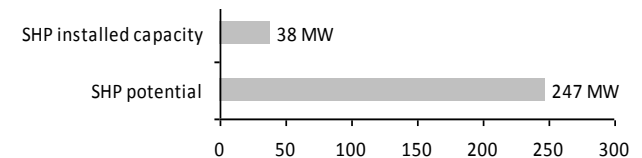


Figure 2 Small hydropower capacities in South Africa

Source: Barta<sup>7</sup>

After nearly 30 years of neglecting the hydropower potential of the country, the first new small hydropower station was commissioned in November 2009 at the Sol Plaatje Municipality (Free State province), and a few other stations are currently in different stages of development.

The South African Renewable Energy Database, as developed by the Council for Scientific and Industrial Research (CSIR), Eskom and the Department of Minerals and Energy, investigated the available renewable energy resources in the country, including the potential for hydropower.<sup>8</sup> As follow-up, the resources available for the Eastern Cape region was detailed as part of a three-year investigative project entitled 'Renewable energy sources for rural electrification in South Africa'. The primary objective of the latter project was to identify the commercially viable opportunities for rural electrification in the Eastern Cape Province of South Africa using wind-,

hydro- and biomass-powered energy systems. The maps in figures 3 and 4 present the outcomes of these two studies with respect to the potential for small

hydropower in South Africa and the Eastern Cape respectively.

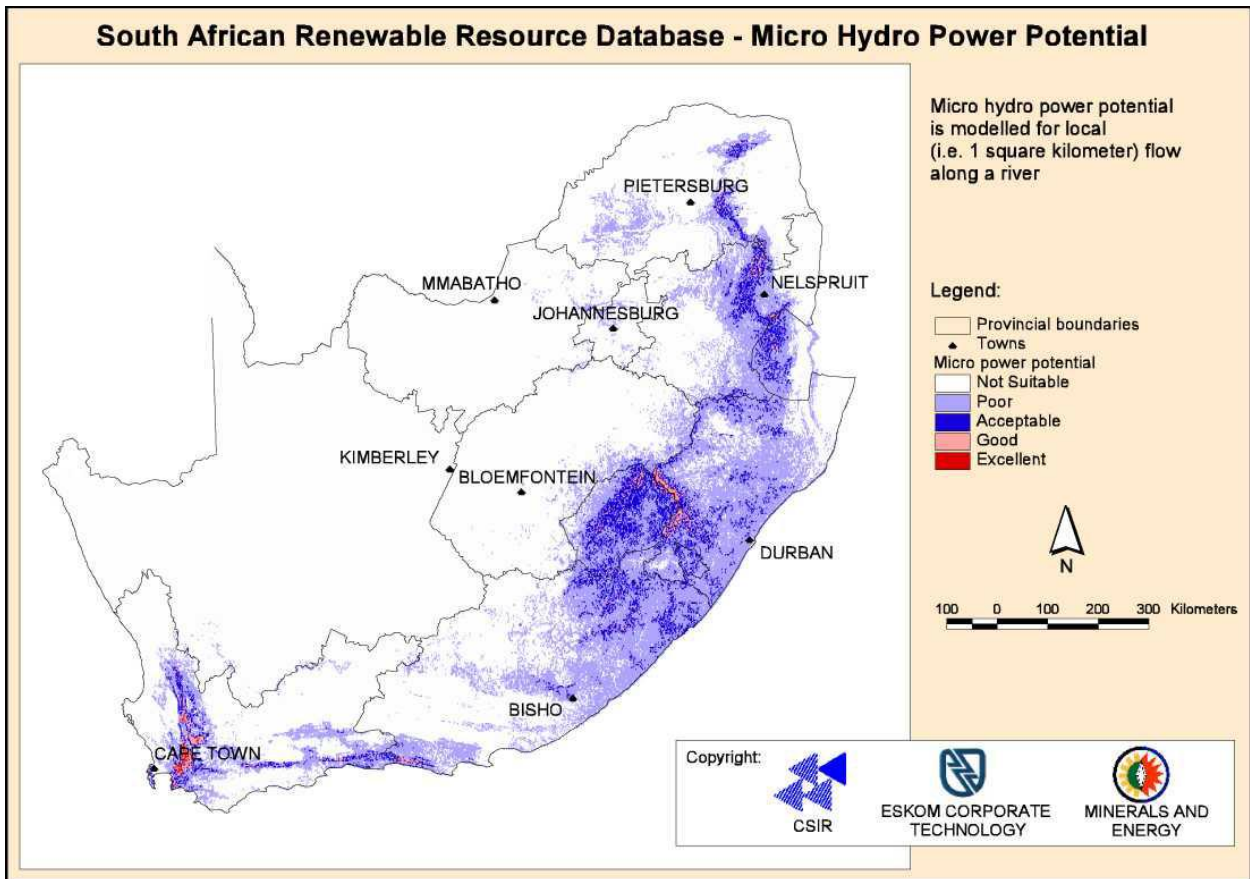


Figure 3 Micro hydropower potential in South Africa  
Source: Muller<sup>8</sup>

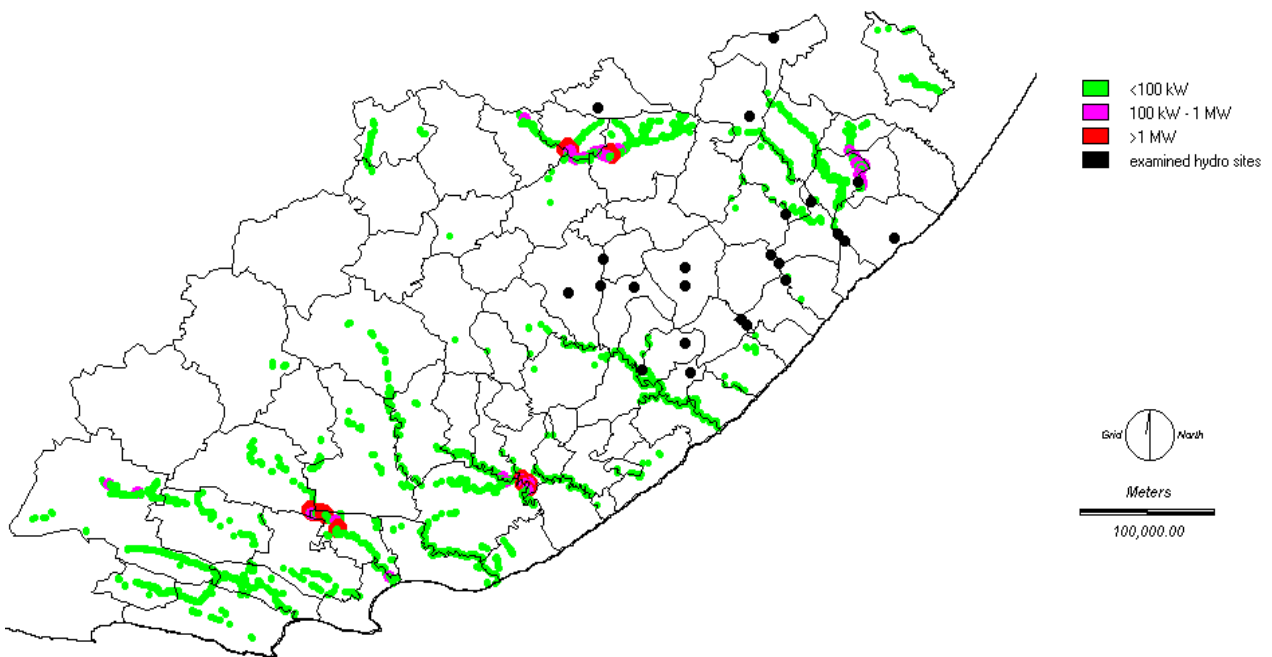


Figure 4 Small hydropower potential in the Eastern Cape of South Africa  
Source: Szewczuk, Fellows, and van der Linden<sup>9</sup>

Installed hydropower capacity under 10 MW has the potential to be further developed in the rural areas of the Eastern Cape, Free State, KwaZulu Natal and Mpumalanga.<sup>7</sup> A later publication by Barta (2011) includes new insights regarding the potential of small hydropower in South Africa by including the hydropower potential of water transfer systems and gravity-fed water systems, and mentions a total potential of 247 MW of which 38 MW have been developed (figure 2).

At the moment Eskom is operating two small hydropower stations: First Falls (6 MW) and Ncora (1.6 MW). Municipalities operate another three grid-connected small hydropower stations, while companies in the private sector run another two, both grid-connected. There is a substantial number of micro hydropower systems that are in operation, mainly in the KwaZulu Natal and Eastern Cape region, supplying primarily individual farmers.

There are a few small-scale hydropower installations currently not in operation, which could be refurbished to working order, like the ones at Belvedere (2.2 MW), Hartbeespoort (37 kW) and others.<sup>3</sup>



Figure 5 Interior of the decommissioned Hartbeespoort plant in South Africa

Source: Author

Note: The plant was in operation between 1924 and the mid-1960s, and could be rehabilitated/upgraded.

With the main economic hubs located in areas suffering from water scarcity, the South African economy is heavily reliant on water transfer systems. Several water distribution companies are currently looking into the possibility of using in-flow hydropower turbines for electricity generation. As part of the research project by University of Pretoria, a 16-kW pilot system has been installed at the Pierre van Ryneveld reservoir in Pretoria, with preparations ongoing for more systems nationwide.<sup>7</sup>

Below are examples of small hydro projects:

The First Falls small hydropower station has two 3-MW units, with provision for a future third machine. Water is conveyed to the powerhouse through a 27-metre long penstock with a 2.7-metre diameter steel pipe. The water for the station is discharged at  $6\text{m}^3/\text{sec}$  from Mthatha dam, down the river to First Falls. The Ncora small hydropower station has a single 1.6 MW unit supplied by a 260-metre by 1.6 metre diameter penstock operating at 4 bar. The water is released from the main Ncora dam via a canal to the holding dam.<sup>10</sup>

On the Dorps River, north of the town of Lydenburg, the Thaba Chweu Local Municipality owns a small hydropower station since 1982 called Lydenburg. It has a Gilkes Pelton turbine of 2.6 MW capacity. The system is privately operated by MBB Consulting Engineers of Nelspruit, under a contract with the local municipality.<sup>11</sup>

In the early months in 1926 and in 1953, the town of Ceres commissioned its first and second small hydropower schemes, with capacities of 95 kW and 1 MW respectively.<sup>12</sup> Unfortunately, this scheme is no longer operational, although rehabilitation could be considered.

The Friedenheim station consists of two Sulzer Francis turbines of 1 MW each. Water for the station is taken from approximately 5.5 km upstream from the Krokodil River, and is transported to the power house site where a head of 64 metre is available.<sup>13</sup> The station has been running since 1987. It sells bulk of the generated electricity through a Power Purchase Agreement (PPA) to the local Mbombela Municipality. It is owned by the members of Friedenheim Irrigation Board (FIB) and is operated on behalf of the MBB Consulting Engineers. The plant provides power for water pumping to FIB, but 93 per cent of the power generated is sold to the municipality through a PPA that sets the tariff at 12 per cent below the price at which it buys power from Eskom (its bulk electricity provider).<sup>14</sup>

Bethlehem Hydro Pty Ltd owns two small hydropower stations that are normally referred to as 'Bethlehem Hydro'. These were the first addition of hydropower generation capacity for the last three decades. The system consists of:

- The 3 MW Sol Plaatje Power Station near the town of Bethlehem. This station was commissioned in November 2009 and has a generating head of approximately 11 metre and a maximum flow of  $30\text{ m}^3/\text{s}$ . One 2.1 metre-diameter Kaplan turbine, attached to a generator, is installed at the power station.

- The 4 MW Merino Power Station is close to the town of Clarens. The project consists of a diversion weir with a semi-circular spillway in the Ash River, a 700-metre long canal to transfer the water to the power station, a small fore-bay and a power station situated in a sandstone bank from where the water is returned to the Ash River. The generating head is approximately 14 metre and a single Kaplan turbine and a generator are installed in the power station.<sup>11</sup>

The Bakenkop small hydropower plant was commissioned in 1950 to supply the town of Piet Retief with electricity before it was connected to the national grid. After 60 years of operation, it is still providing power to the town. The installed capacity is 800 kW. The system operates intermittently depending on water availability. At present it provides electricity at an average cost which is half that of the rate the town pays to Eskom for its power.<sup>14</sup>

The future for small hydropower in South Africa will see two main parallel tracks: grid-connected projects that will feed into the national grid and small scale systems for private use (not feeding into the grid, irrespective of whether a grid connection is available or not). These tracks can be supplemented by a third category of isolated systems for rural electrification purposes. The grid-tied systems future is closely linked to the national government's policy on renewable energy development. The utilization of small scale systems for private use is expected to grow based on the foreseen rise in electricity prices, coupled with the reduced reliability of the grid. Off-grid electrification by means of small hydropower could fall under the 'Working for Energy' programme, as it is currently under development by the South African National Energy Development Institute (SANEDI). It could also be supported by the renewed focus of the Department of Energy in the off-grid electrification processes.

### Renewable energy policy

In 2010, the Department of Energy presented the Integrated Resource Plan (IRP), outlining the electricity generation mixes for the period up to 2030.<sup>3</sup> According to the policy, the adjusted development plan will see 17.8 GW of renewable energy as part of the energy mix in 2030. The main source of hydropower in the IRP will come from imported electricity (approximately 5.2 GW by 2030), while local, small hydropower shares an allocation of 125 MW alongside landfill gas electricity.<sup>15</sup>

In March 2009 the energy regulator National Energy Regulator of South Africa (NERSA) announced the Renewable Energy Feed-In Tariffs (REFIT) for a

selected number of renewable energy technologies. Small hydropower (between 1-10 MW) qualified for a REFIT of ZAR 0.94/kWh (approximately € 0.074 or US\$0.096).<sup>16</sup> However the unclear legal status of REFIT and the would-be buyers of that electricity prevented power-purchase agreements (PPAs) from being signed for this tariff. The REFIT review in 2011 did see adjustments in the REFIT-based on inflation, capital costs and other assumptions. The REFIT for small hydropower was revised downwards by over 28 per cent, to ZAR 0.671/kWh (about €0.065 or US\$0.089).<sup>17</sup>

Concurrent to the REFIT review, the South African Government announced its intention to start a competitive bidding process for electricity from renewable sources. The Request for Proposals was issued in August 2011. As the bids would be evaluated in a two-stage procurement evaluation process that includes qualifying criteria based on economic development requirements, as well as price, the REFIT process was consequently side-tracked.<sup>15</sup>

In the Renewable Energy Independent Power Producer Procurement Programme (REIPPP) a total of 3,725 MW is to be procured by the Government, with an allocation of 75 MW for small hydropower (up to 10 MW).<sup>18</sup> The bidding process will see a number of bidding rounds, of which the first has been concluded with allocation of 1,415 MW to 28 bidders, none of which involves hydropower.<sup>19</sup> The second round of REIPPP provided two hydro developers with preferred bidder status: the Neusberg plant of Kakamas Hydro Electric Power and the Stortemelk plant of NuPlanet (4.47 MW). Although the Neusberg site has a potential of 12.57 MW, only 10 MW will be developed in order for it to qualify under the REIPPP.

### Barriers to small hydropower development

The main barrier for development of hydropower in South Africa has long been the unclear policy framework from both electricity as well as a water use perspective. With REIPPP, the policy framework is much clearer, although effectively limiting options as development of grid feeding hydro schemes outside the REIPPP has become virtually impossible.

### Note

i. This 700 MW refers to traditional hydro schemes only and excludes imported hydropower from Mozambique and pumped storage.

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