Energy Storage in South Africa

SAESA | South African Energy Storage Association

First Meeting of the Energy Storage Partnership

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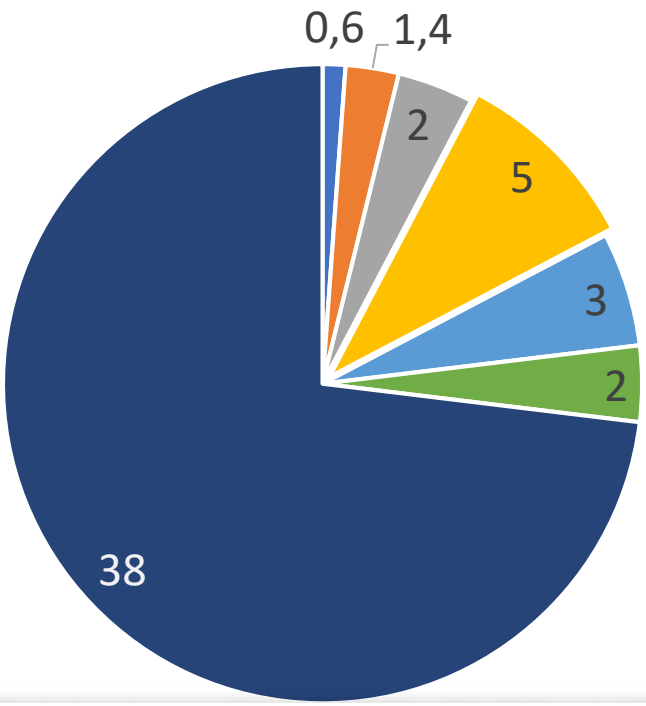
Energy & Extractives

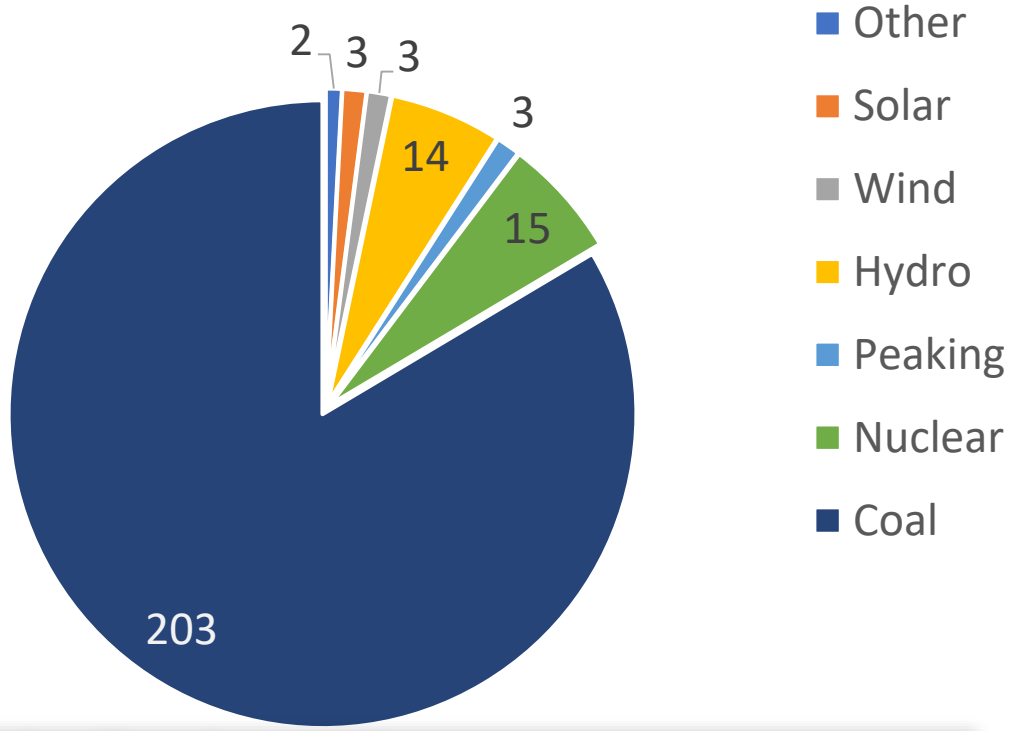
ESMAP
Energy Sector Management Assistance Program

South Africa Power Sector Snapshot – Gx and energy mix

Break down of SA 52 GW of installed capacity (2016)



Break down of SA 245 TWh p.a. electricity production (2016)



- SA's power sector dominated by national utility Eskom and "baseload" coal generation
- Solar (mostly PV with ~450MW of CSP) and wind IPPs introduced from 2011 through multi-round REIPP programme, which has been a major political flashpoint;
- 9GW of new coal slowly being added through two delayed megaprojects, while another 15GW of old coal plants should be retired in the next 10 years;
- SA is by far the largest exported in the Southern African Power Pool, which has an electricity market;

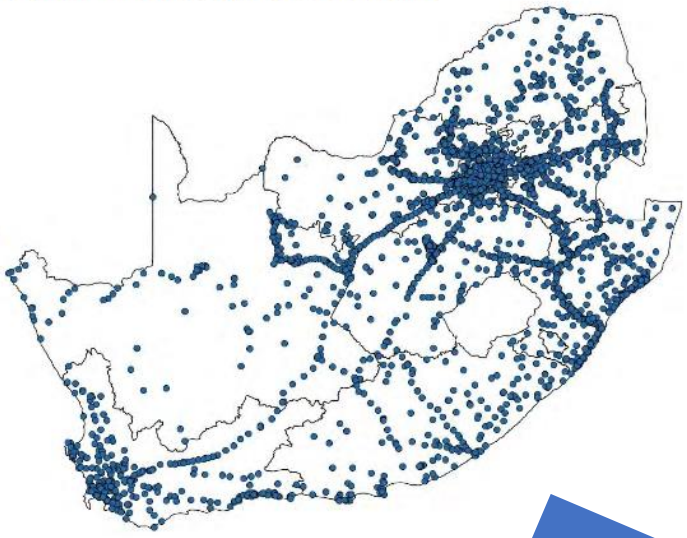
Source: CSIR

South Africa Power Sector Snapshot – Tx & Dx

- South Africa has an expansive and radial power system, run by Eskom;
- The network is designed to transmit significant amounts of power from the generation near coal mines in the northeast to significant load centres in the south and southwest;
- At least 1 in 4 Tx and Dx networks is already overloaded in SA;

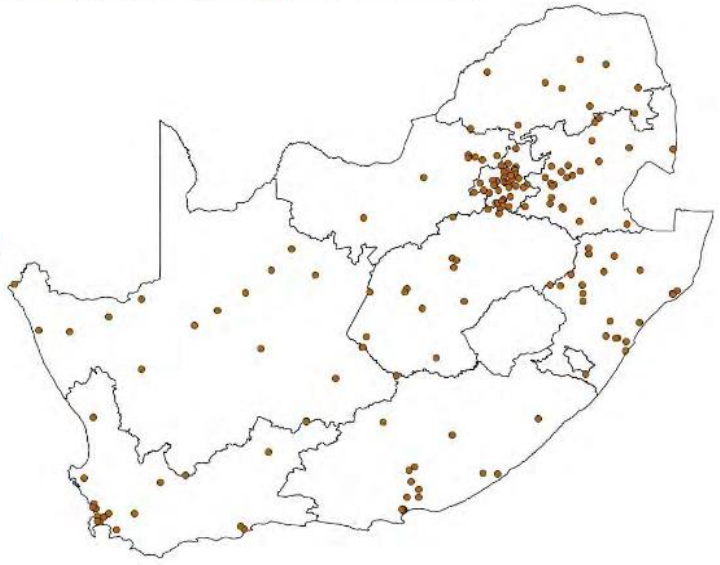
Installed Distribution transformation capacity 101 197 MVA[1]

1: Eskom Integrated Report 2016



Installed Transmission transformation capacity 143 440 MVA[1]

1: Eskom Integrated Report 2016



- Dx is split between Eskom and a large amount of municipal utilities, who distribute ~40% of the electricity and connect ~60% of consumers;
- Municipalities use electricity tariffs as a funding source for government budgets beyond paying for the Dx
- Distribution networks are unevenly located across the country;
- A successful electrification programme since advent of democracy in 1994 has increased access from just over 40% to 85-90% of the ~57m population;

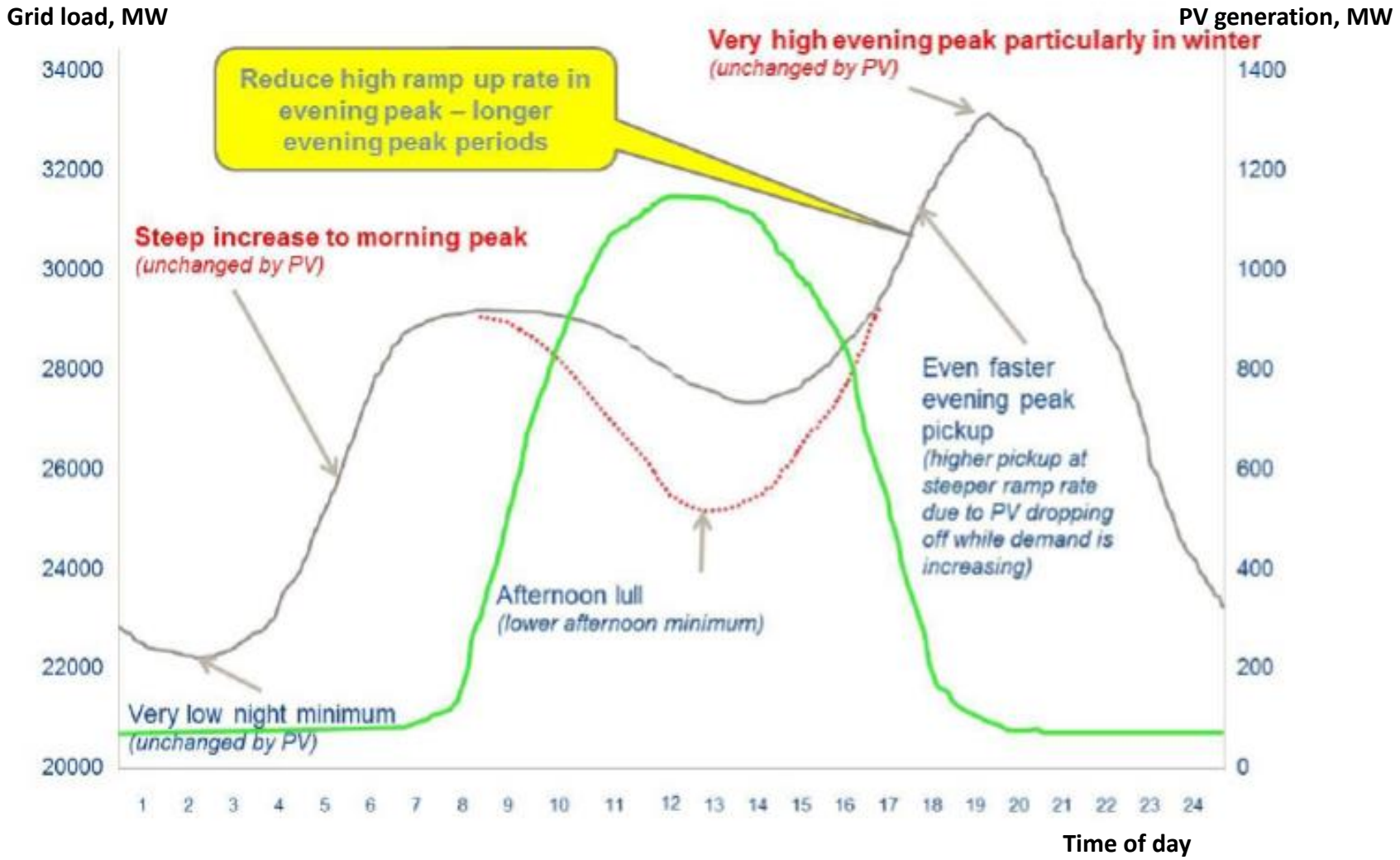
Source: Eskom, DOE

South Africa Power Sector Snapshot – challenges on regulation

- Regulation
  - SA has both an **Integrated Energy Plan and Integrated Resource Plan** but they were last approved circa 2010 and any project that deviates from these requires the Minister's approval;
  - **New plans** have been drafted many times but **never formally approved**, stagnating the sector (a revolving door of ministerial appointments has not helped);
  - New technologies, such as solar and wind are thus constrained by regulation, especially in distributed generation, where anything above 1MW requires a licence;
  - An independent **regulator exists (NERSA) but is weak** and follows direction of Department of Energy;
  - **Electricity prices** were intentionally kept low after democracy, which led to underinvestment and since 2008 degradation of system performance (Gx availability is just above 60%). Prices have been rising significantly this decade but remain cheap compared to global terms (~USD0.07-8/kWh wholesale, about twice that for retail) and still 20-25% below cost (according to CSIR);

South Africa Power Sector Snapshot – challenges on generation

South Africa does not yet have a "duck curve" issue, as RE adoption has been slow, but it is expected, especially if upcoming reforms to small scale embedded generation rules are enacted

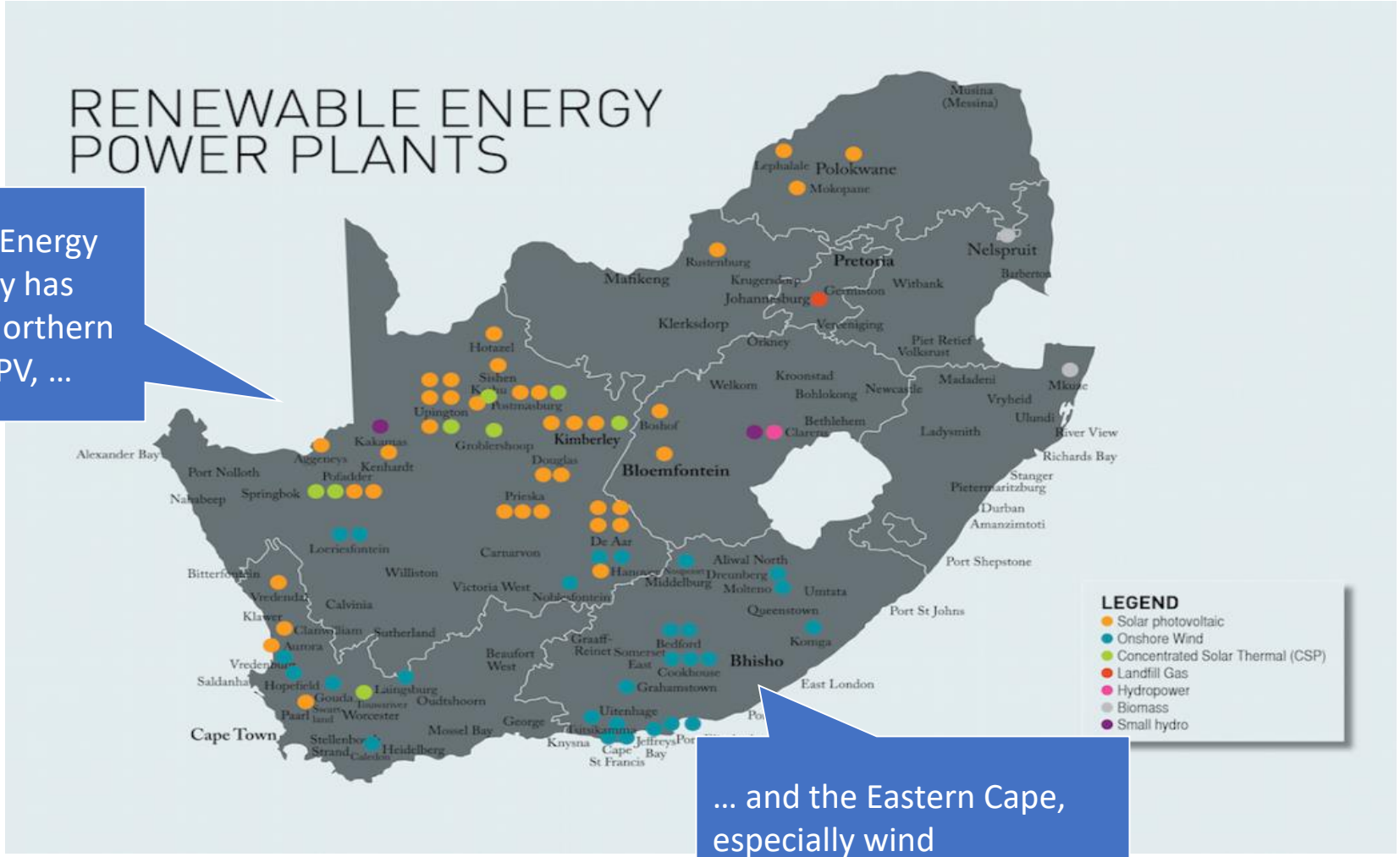


Source: Eskom

South Africa Power Sector Snapshot – Challenges on Tx & Dx

There is currently a regional misalignment between the location of new renewables and existing transmission and distribution infrastructure

Most new Renewable Energy IPP generation capacity has been installed in the Northern Cape, especially solar PV, …



… and the Eastern Cape, especially wind

Source: Eskom, DOE

South Africa Power Sector Snapshot – challenges other

- Death spiral of national utility - Eskom
  - Lower system performance (i.e. periods of “load shedding”), delays in new construction, inefficient labour structure and higher electricity prices have led to decreasing electricity demand and revenues for the utility (requiring even faster price increased);
  - Current debt levels approaching R500b (USD 35b);
  - Restructuring into separate Gx, Tx and Dx units started but adding more uncertainty;
- Large variability in potential demand growth, due to SA exposure to commodities and global economy (plus, it is a developing economy);
- High national unemployment rate that politicises risk of coal mine closures and need for local manufacturing of new energy technologies;
- Strong domestic and international lobbies for coal, nuclear, gas and renewable energy, all of which have conflicting viewpoints on the future;

Current storage is primarily almost 3GW of pumped hydro

Drakensberg Pumped Storage

Installed capacity: 1000MW (for 28 hrs)

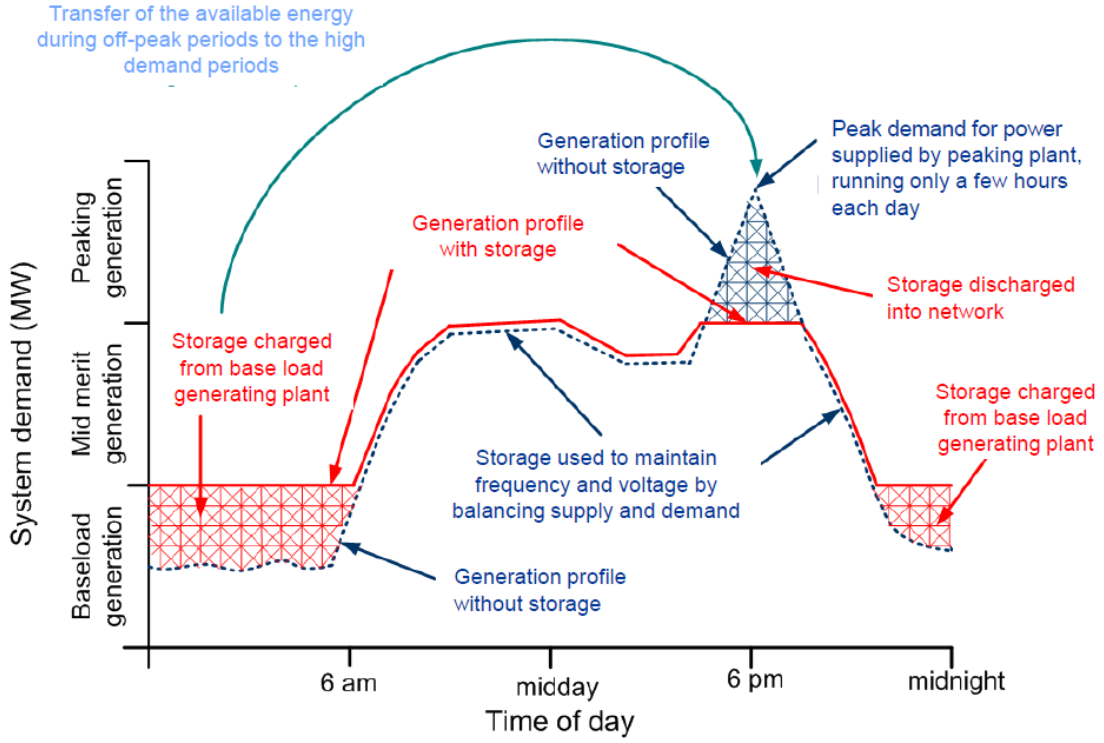
Palmiet Pumped Storage

Installed capacity: 400MW (for 28 hrs)

Ingula Pumped Storage

Installed capacity: 1332MW (for 14 hrs)

- The traditional use of pumped hydro has been peak shaving and frequency & voltage balancing;
- Because "storage" has been so large historically, all grid-connected storage is classified as generation;
- An additional ~300MW of thermal storage has been added recently with CSP



Source: Eskom – Peter Langley

Eskom also has been a battery testing facility at a micro-grid research centre

Specification:

- Capability to test 5 x 200kW 1.2MWh different battery technology units
- All tested under identical load discharge profiles
- Output of the 5 units is then synchronised and fed back into the grid, as if they were a single 1MW battery unit, in order to demonstrate the effectiveness of this form of energy storage.

Objectives:

1. Demonstrate the effectiveness of battery energy storage at a grid scale.
2. Test individual battery technologies under real operating test regimes
3. Identify the best technology for various applications
4. Establish the probable life cycle of each of the various technologies under real working conditions
5. Establish the round trip efficiencies of the various units
6. Give Eskom insight into the future installation of commercial battery storage units of the Megawatt scale.

- The site has three units at the moment
  - Lithium ion phosphate battery by BYD (China)
  - Sodium nickel chloride battery by GE (USA)
  - Vanadium redox flow battery by UET (USA)
- A fourth system of zinc-bromine from Primus Power (USA) is announced

Source: Eskom – Peter Langley

On Robben Island a solar PV + battery mini-grid was installed in 2017 to reduce costly diesel generation

- **Energy Storage System:** 500kW / 837kWh lithium-ion battery (ABB)
- **Technical specifications:** BESS coupled with a new 666kW solar PV farm, which is connected into the island's mini-grid (and 3MW of existing diesel generators). At the time it was "the largest off-grid battery project in the southern hemisphere;"
- **Business model:** tender process and direct purchase of the integrated solution by the Department of Tourism;
- **Environmental and social:** Extra precautions were taken due to sensitivity of the area and high humidity and salt content of the air. Post construction, a seagull colony nested right next to the PV plant, leading to considerably more cleaning than planned;
- **Project status**: Operational since October 2017, generating around 110,000kWh and avoiding around 800 tons of carbon emissions (as of May 2019)

Source: www.esi-Africa.com – "Behind the scenes: Robben Island's solar"

WB is supporting a 1400MWh BESS programme at Eskom

- **Energy Storage System:** multiple battery technologies will be allowed to tender
- **Technical specifications:** sizes vary from 1-40MW, with average durations of 4 hours, spanning anywhere from 12 to 90 sites
- **Business model:** tender for battery plus EPC integration, with batteries to be owned and operated by Eskom
- **Disposal and recycling:** n/a
- **Environmental and social:** n/a
- **Project status**: first set of tenders expected within weeks, with first sets of installations needed to be operational by end of 2020 and full programme delivered by end of 2022;

Source: Eskom – Prince Moyo; World Bank – Frederick Verdol

Key issues and apprehensions

- **Safety** – unclear how a) fire risk or b) environmental (spill, other damage) risks should be assessed, categorized, quantified and managed
- **Technology** – technology options are well understood; however, less clear is a) how technologies will actually perform (e.g. availability, efficiencies, degradation) and b) how they should be integrated and then controlled centrally
- **Standards** – most likely that SA will adopt international standards, once these are produced. Local standards are being created for grid-connection by Eskom, with input from private sector;
- **Commercial aspects** – key issues include a) how to get fully-wrapped solutions (EPC+AC battery) without massive costs rather than individual components and b) how to involve the private sector
- **Guarantees, warranties** – issues tied to size / bankability of smaller & non-lithium battery suppliers
- **Supply chain issues ? Logistics?** – South Africa is far away from all manufacturers, leading to longer delivery times (but still not as challenging as other countries in SSA)
- **Limited local capacity?** – significant experience and expertise with renewable energy and electronic technologies but not with batteries
- **Local content** – major questions about how ESS/BESS will translate into new jobs in South Africa, both in domestic deployment and global supply chain participation;

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