South African Power System transition, challenges and state of play

System Operator

13 September 2023

The South African Power System in a slide

Type	Number	Nominal capacity
Coal-fired	14 stations	39 099 MW
Gas/liquid fuel turb	4 stations	2 409 MW
Hydroelectric	6 stations	661 MW
Pumped storage	3 stations	2 724 MW
Nuclear	1 station	1 854 MW
Wind energy	1 station	100 MW
Dispatchable IPP	2 stations	1 005 MW
Wind IPP	34 stations	3 343 MW
Solar PV IPP	45 stations	2 287 MW
CSP IPP	6 stations	500 MW
Other renewable IP	7 stations	51 MW
Total Eskom	29 stations	46 847 MW
Renewable (IPP &	93 stations	6 281 MW

The EAF for the Eskom generators for the financial year to date is 55.2%

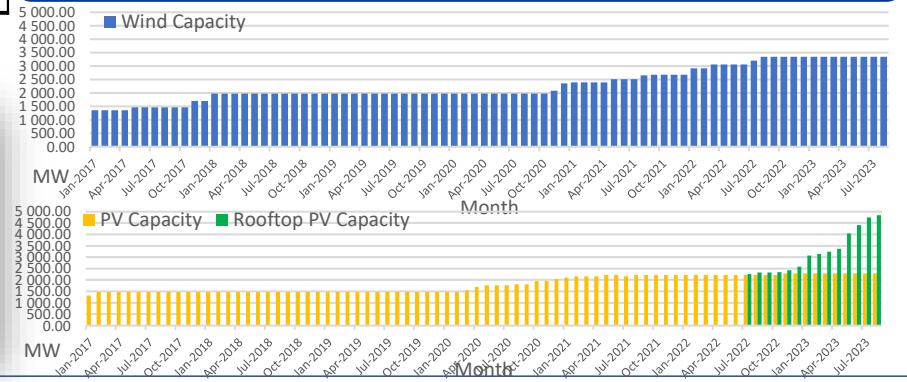
Arnot Power Station

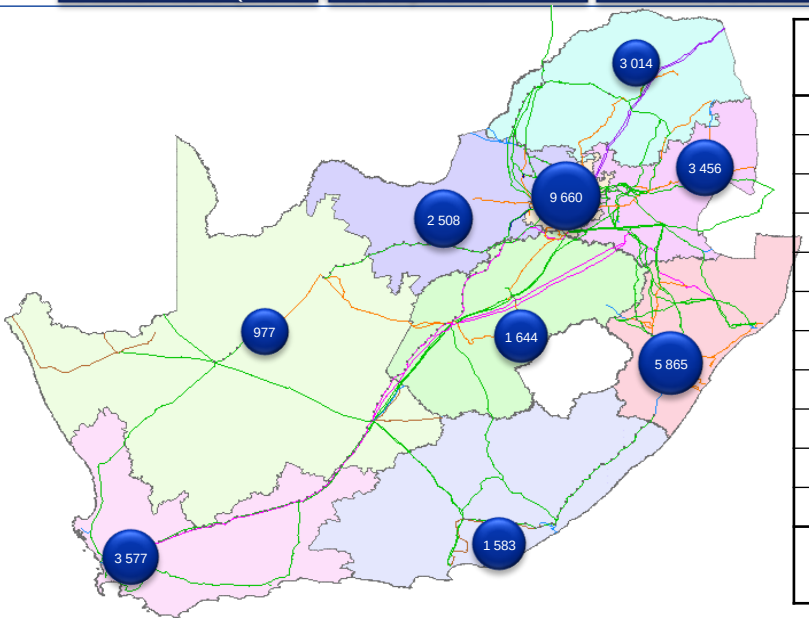
Current Installed Capacity (MW)	
CSP	500.0
PV	2,287.1
Wind (Eskom+IPP)	3,442.6
Total (Incl other REs)	6,280.2
Estimated Rooftop PV	4,841.0

Sere Wind Farm

Maximum Contribution (MW) - based on System Operator data (subject to metering verification)					
Cal Year	Indicator	CSP	PV	Wind (Eskom+IPP)	Total (Incl other REs)
All Time	Maximum	506.2	2,099.5	3,102.2	5,126.1
	Max Date	15-Mar-2022 15:00	24-Oct-2021 12:00	25-Aug-2023 20:00	05-Sep-2022 12:00

The highest contribution from renewables was 21.8% on 20 February 2023 (Monday) at 15:00





Annual peak demand (Mon 10-Jul-2023 18:00-19:00)	
Eastern Cape	1 583
Free State	1 644
Gauteng	9 660
Kwa-Zulu Natal	5 865
Limpopo	3 014
Mpumalanga	3 456
Northern Cape	977
North-West	2 508
Western Cape	3 577
International	1 368
Losses	220
RSA Contracted Demand	33,873

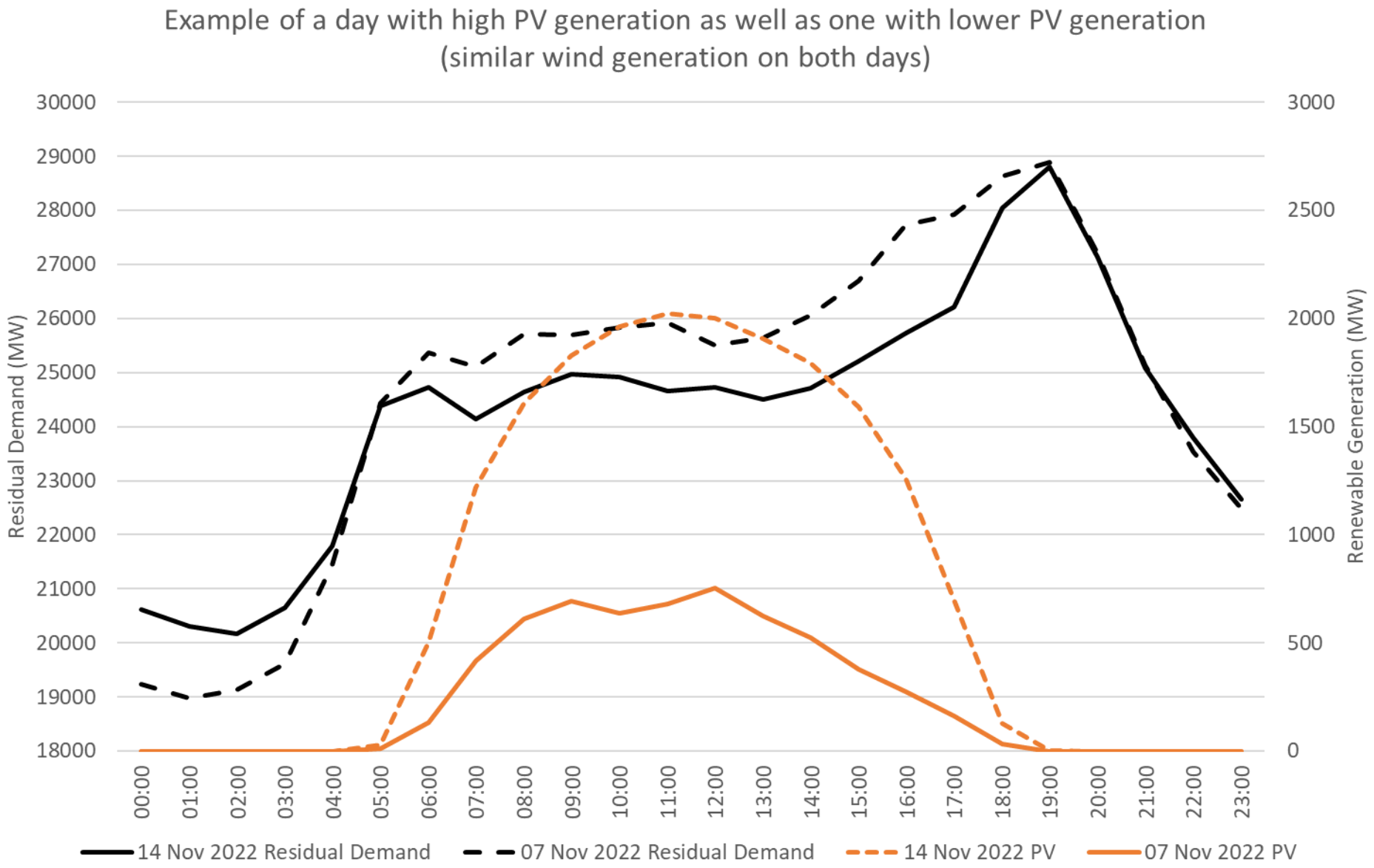
Transmission lines	km
765 kV	2 784
533 kV HVDC	1 032
400 kV	19 916
275 kV	7 342
220 kV	1 352
132 kV	766
Total	33 192

A large, isolated, sparse transmission network with long, high voltage lines

Transmission substations	
No. of substations	169
No. of transformers (> 30 MVA)	449
Transformer MVA installed (>30MVA)	154 500

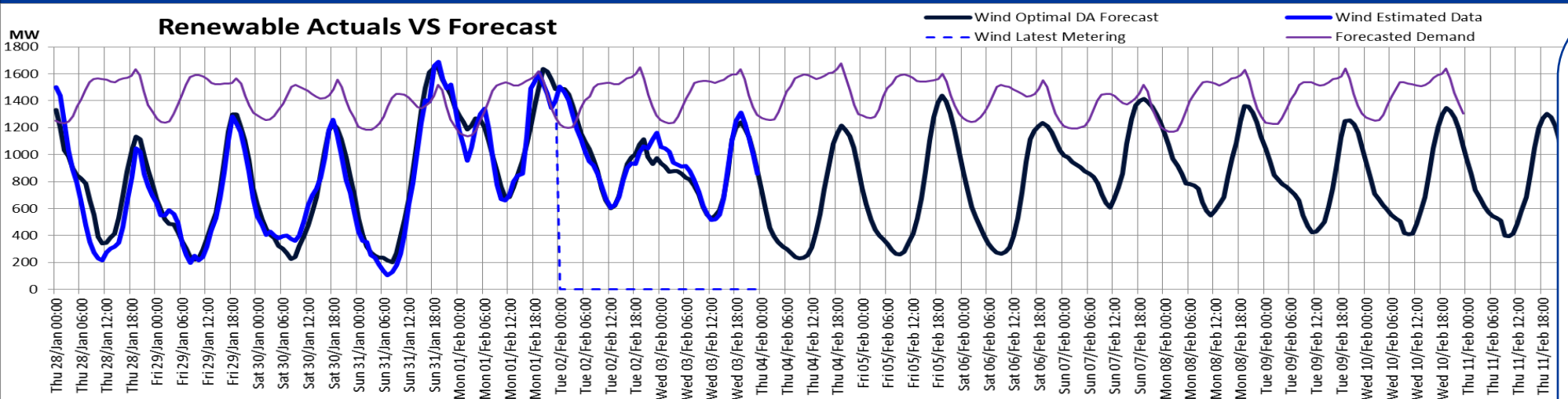
Moving a 400 metric ton transformer

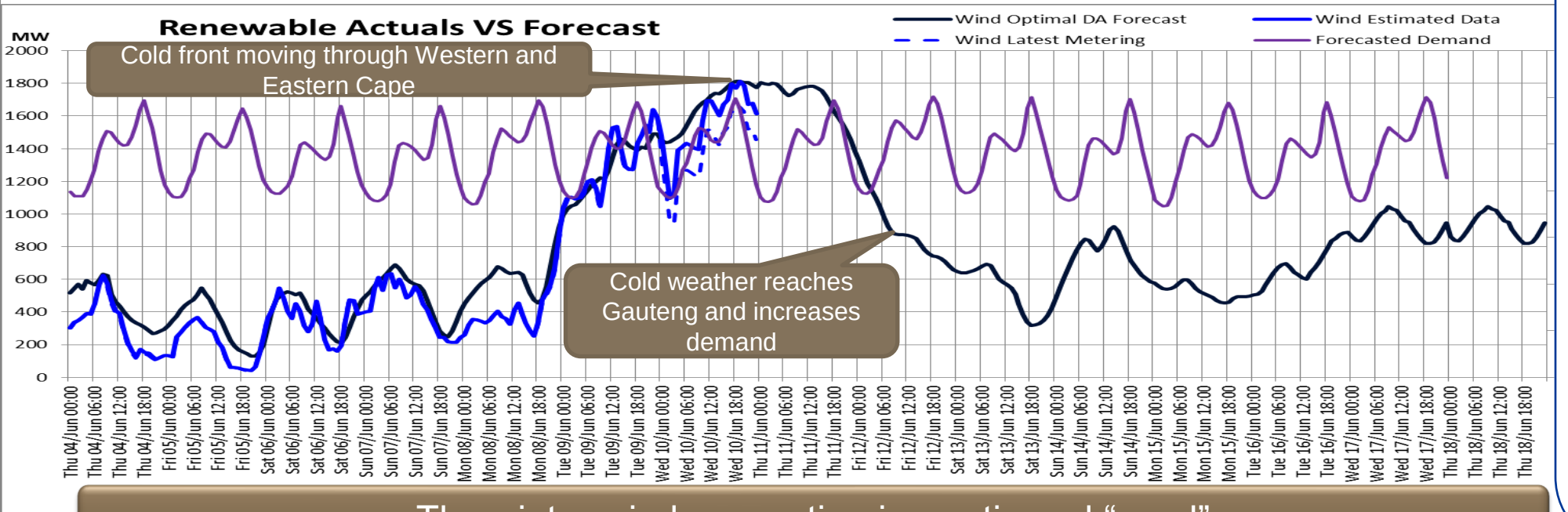
Variability of renewable generation in SA



There is approximately 4800MW of rooftop PV installed in the country, about 1000MW in the densely populated Gauteng province. During overcast conditions, this 1000MW is drawn from the grid. During continuous, higher stages of load shedding, battery inverter systems recharge from the grid after load shedding adding an additional 1000MW burden to the grid. This often happens simultaneously adding 2000MW of additional demand to the grid.

Wind generation





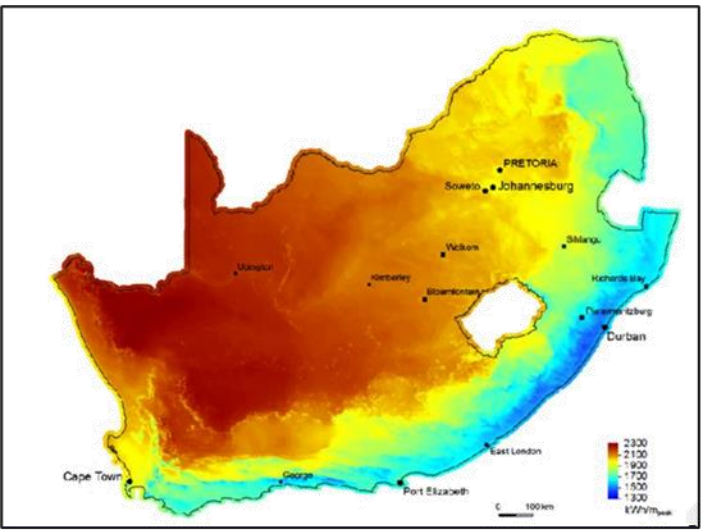
The winter wind generation is erratic and “cruel”

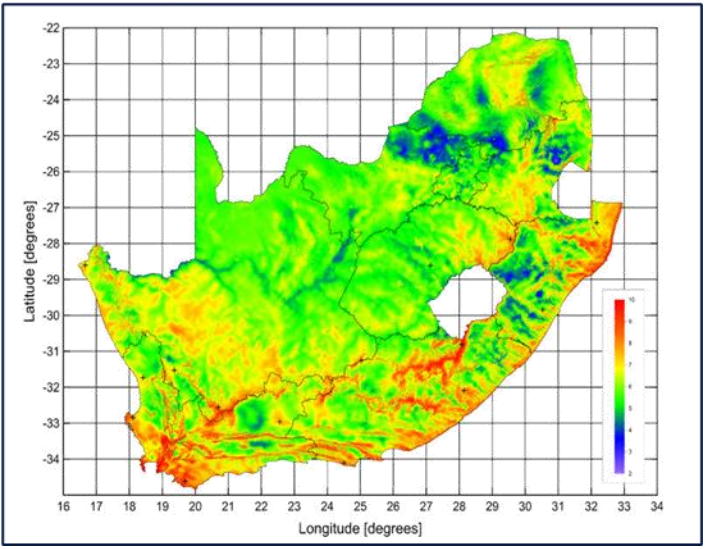
During the summer months, the wind generation aligns almost perfectly to the high evening peak demand and the low night minimum demand.

However, in winter, when the cold front passes through the Western and Eastern Cape, the wind generation increases significantly.

As the cold front arrives in densely populated Gauteng, the cold weather drives demand for electricity up and at the same time the wind generation reduces significantly due to the low trough behind the front. This double whammy requires 1000’s of MW of generation to be dispatched in a short period of time

Transmission development plan: 2023 - 2032





LEGEND

- Projects in execution
- Projects in development
- Projects in concept

Medupi Phase 2 Integration

Nzhelele Integration

Jhb South Strengthening

Jhb East Strengthening

Lowveld Strengthening

NW / Kimberley Strengthening

Kusile Integration

Highveld South Integration

Upington Phase 2 Substation

Northern Cape Strengthening

Northern Cape 765kV Corridor

West Coast Strengthening

Central Cape 765kV Corridor

Peninsula / Mitchells Plain

Eastern Cape 765kV Corridor

Port Elizabeth Strengthening

E-Cape - KZN 765kV Corridor

East London Strengthening

KZN South Strengthening

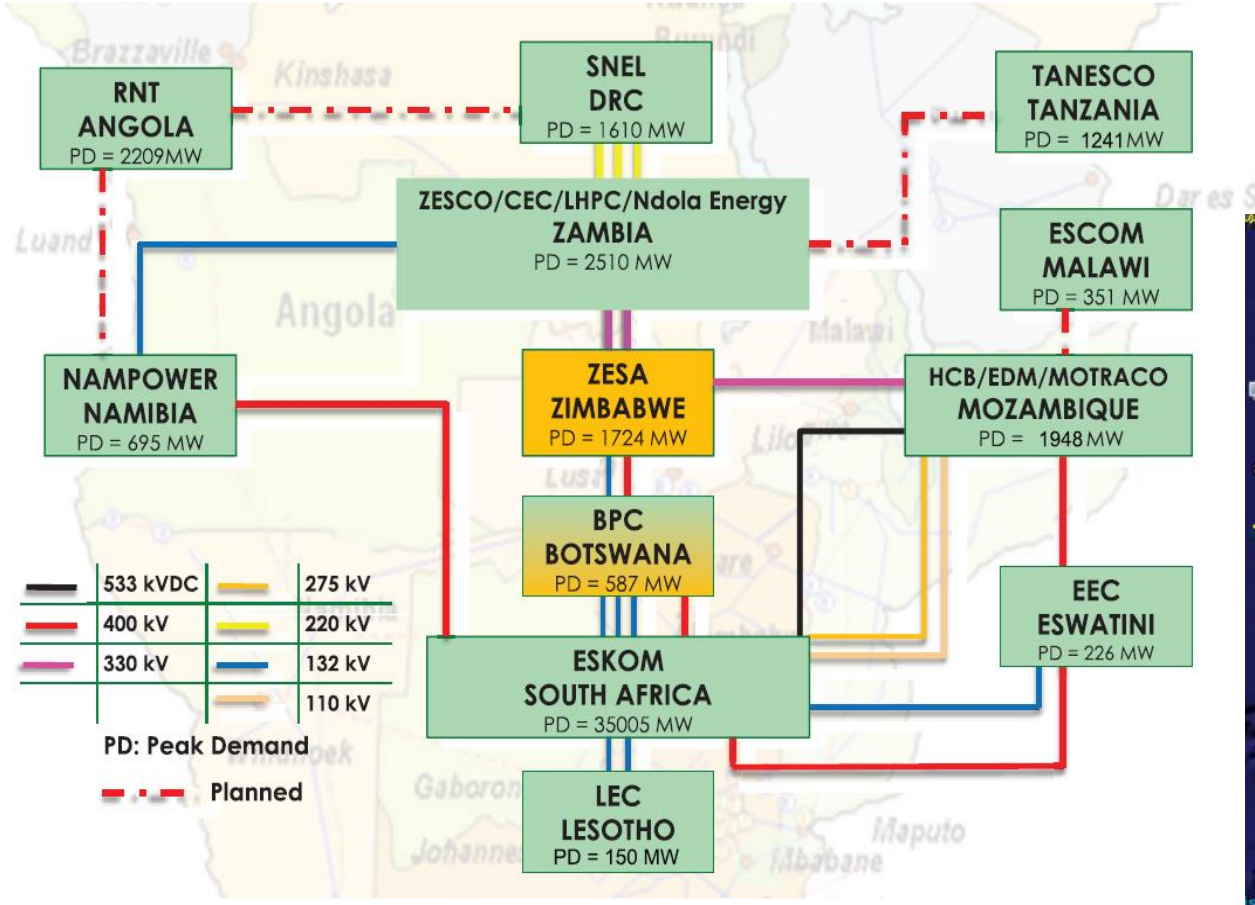
Bloemfontein Strengthening

Empangeni Strengthening

Pinetown Strengthening

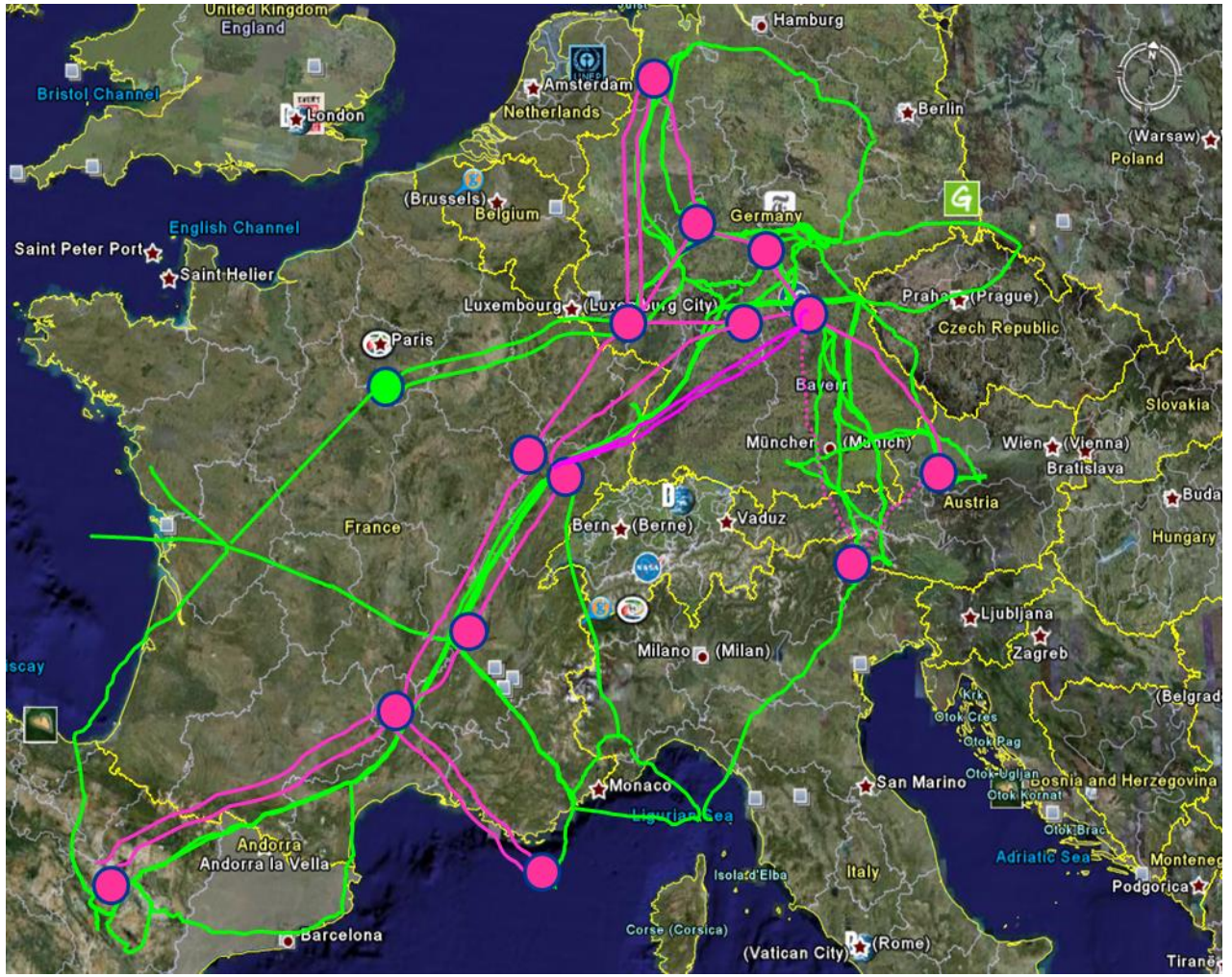
Nzhelele
TABOR
SPENCER
MEDUPI
MATIMBA
MASA
BORUTHO
WITKOP
LESEDING
MERENSKY
SENAKANGWE
Manogeng
SPITSKOP
Silimela
Sekhukhune
DINALEDI
Diphororo
SIMPLON
KOMATIPOORT
NGWEDI
Wildebees
Emkhiweni
APOLLO
KUSILE
MARA
GUMEN
Mahikeng
WATERSHED
ARNOT
KOMATI
MINERVA
MATLA
TUTUKA
GROOTVLEI
CAMDEN
EDWALENI
ZEUS
ALPHA
MADLANZINI
KOKERBOOM
Hotazel
MOOKODI
HERMES
MERCURY
NORMANDIE
FERRUM
MAJUBA
INCANDU
NZALO
Iphiva
ORANJEMOND
LEANDER
EVEREST
THESEUS
UMFOLOZI
Upington
OLIEN
PERSEUS
BETA
INGULA
Duma
Isundu
PEGASUS
Mbewu
INVUBU
HARIB
BOUNDARY
MERAPI
DRAKENSBERG
VENUS
MERSEY
AGGENEIS
PAULPUTS
GARONA
HARVARD
HECTOR
ARIADNE
GROMIS
NIEUWEHOOP
ARIES
NAMA
Groeipunt
Korana
KRONOS
VAN DER KLOOF
ROODEKUIL
SERUMULA
EROS
HELIOS
HYDRA
RUIGTEVALLEI
GAMMA
IZIKO
VUYANI
JUNO
DELPHI
DROERIVIER
POSEIDON
Komsberg
Blouwater
AURORA
KAPPA
PEMBROKE
NEPTUNE
STERREKUS
KOEBERG
ACACIA
BACCHUS
PROTEUS
GRASSRIDGE
PALMIET
Pinotage
Agulhas

International comparisons



Southern African Power Pool interconnections
(SAPP 2021 annual report)

Eskom Transmission network overlayed on Europe



Thank You