
SA'S ENERGY CRISIS AND TRANSITION DYNAMICS

Prof Mark Swilling

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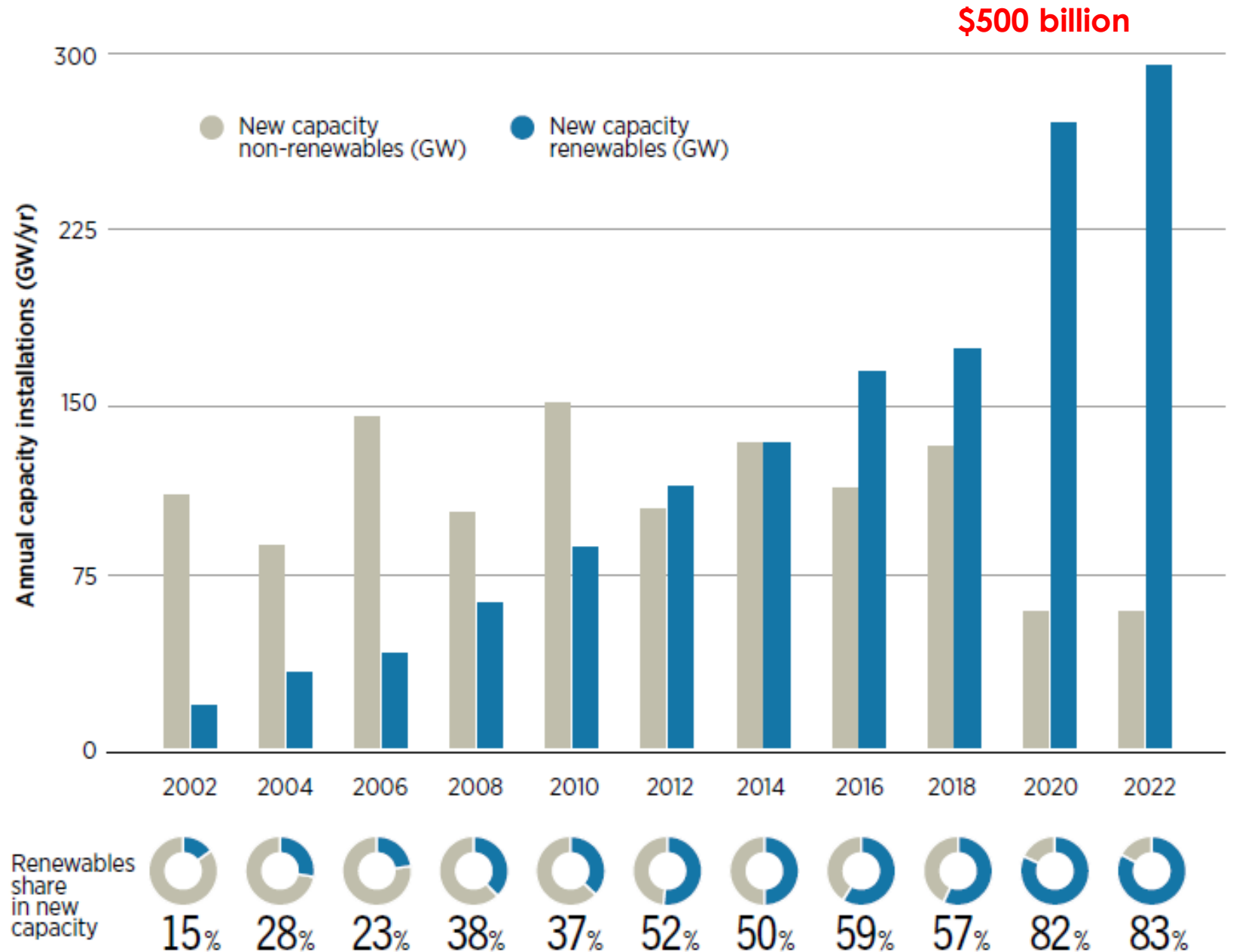
Stellenbosch University

NPC Commissioner

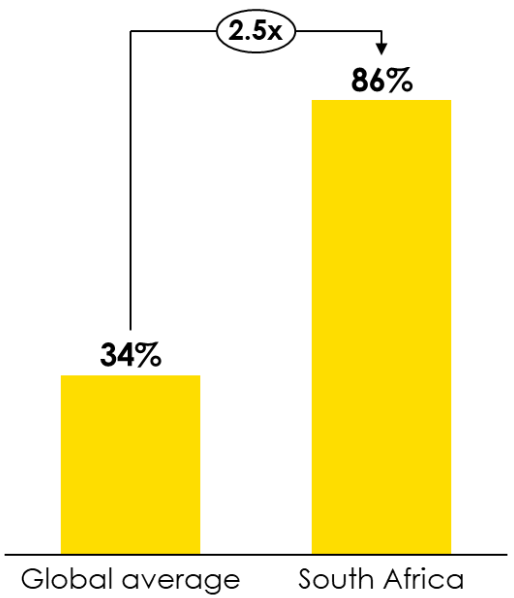
THE GLOBAL MEGA-TREND – CAN SA AFFORD TO MISS THE BOAT?

- Source: Irena, World Energy Transitions Outlook, 2023

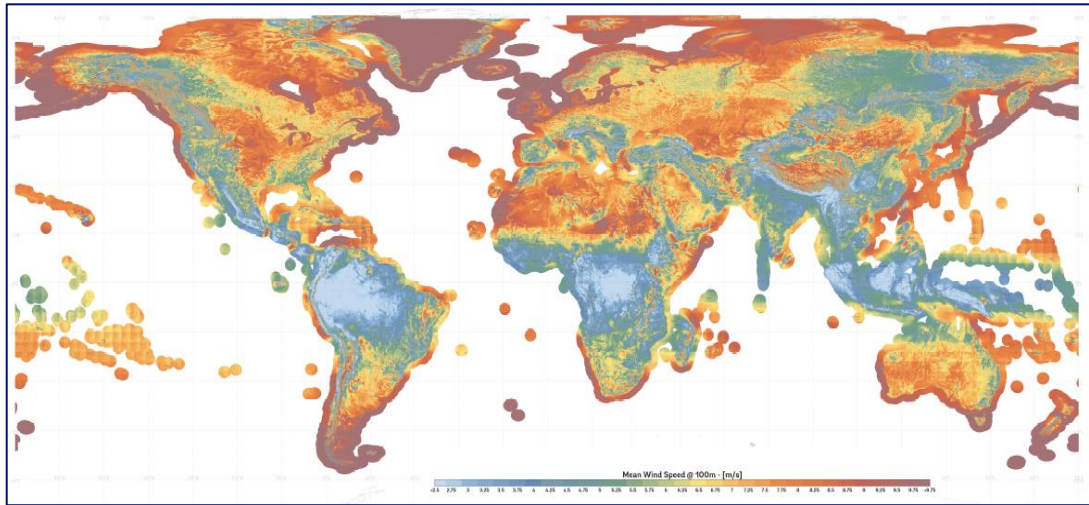
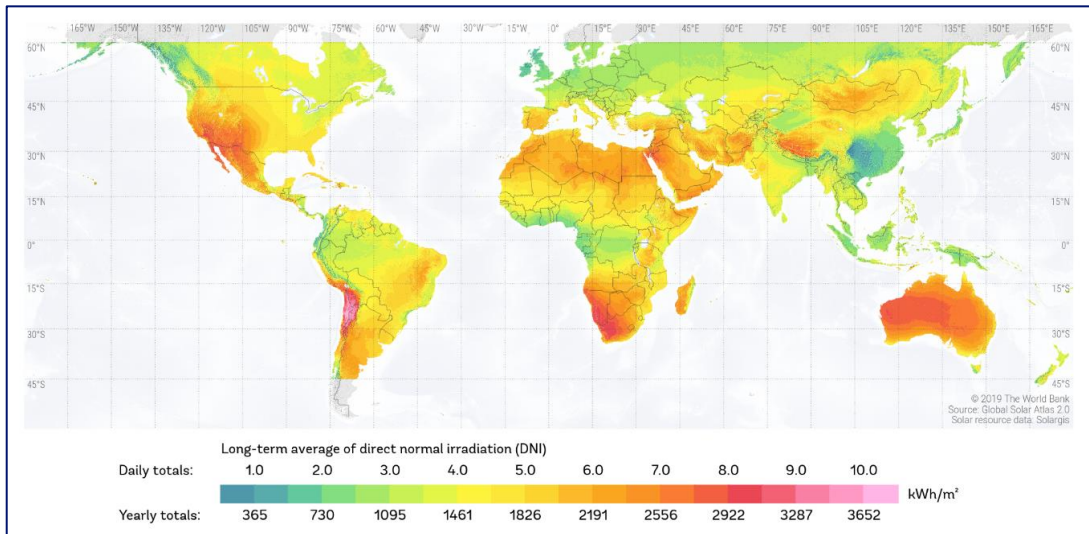
FIGURE 2 Annual power capacity expansion, 2002-2022



SOUTH AFRICA CURRENTLY GENERATES 86% OF ITS ELECTRICITY FROM DOMESTIC COAL-FIRED POWER



South Africa some of the best solar & wind resources globally



Sources: World Bank Group, ESMAP, Solargis, DTU Wind Energy, Vortex

Power Station	Capacity (MW) ¹	Year Commissioned (First Unit) ²	Planned Closure Dates ⁶	Energy Availability Factor ⁸
Arnot	2100	1971	2021-2029	24.6%
Camden	1481	1967 ³	2025 ⁷	56.58%
Duvha	2875	1980	2031-2034	41.69%
Grootvlei	570	1969 ⁴	2025 ⁷	49.97%
Hendrina	1135	1970	2025 ⁷	22.61%
Kendal	3840	1988	2039-2044	37.46%
Komati	114	1961 ⁵	2024-2028	16.84%
Kriel	2850	1976	2026-2030	52.47%
Kusile	2160	2017	2069	73.8% Lower now
Lethabo	3558	1985	2036-2041	80.45%
Majuba	3843	1996	2046-2051	63.45%
Matimba	3690	1987	2038-2042	87.84%
Matla	3450	1979	2030-2034	58.81%
Medupi	3597	2015	2065-2069	54.14%
Tutuka	3510	1985	2035-2041	28.41%

38773

¹ As of March 2021. Source: <https://www.eskom.co.za/wp-content/uploads/2021/08/2021IntegratedReport.pdf>

² Source: <https://www.eskom.co.za/wp-content/uploads/2021/08/2021IntegratedReport.pdf>

³ Source: <https://www.powermag.com/camden-power-station-mpumalanga-province-south-africa/>

⁴ Source: <https://www.eskom.co.za/wp-content/uploads/2021/08/2021IntegratedReport.pdf>

⁵ Source: <https://www.eskom.co.za/heritage/wp-content/uploads/2021/10/Eskom-News-March-2013-insert.pdf>

⁶ Source: <https://cer.org.za/wp-content/uploads/2020/05/Formal-Response-PAIA-ref-0087-Man-Affirmation-that-records-does-not-exist.pdf>

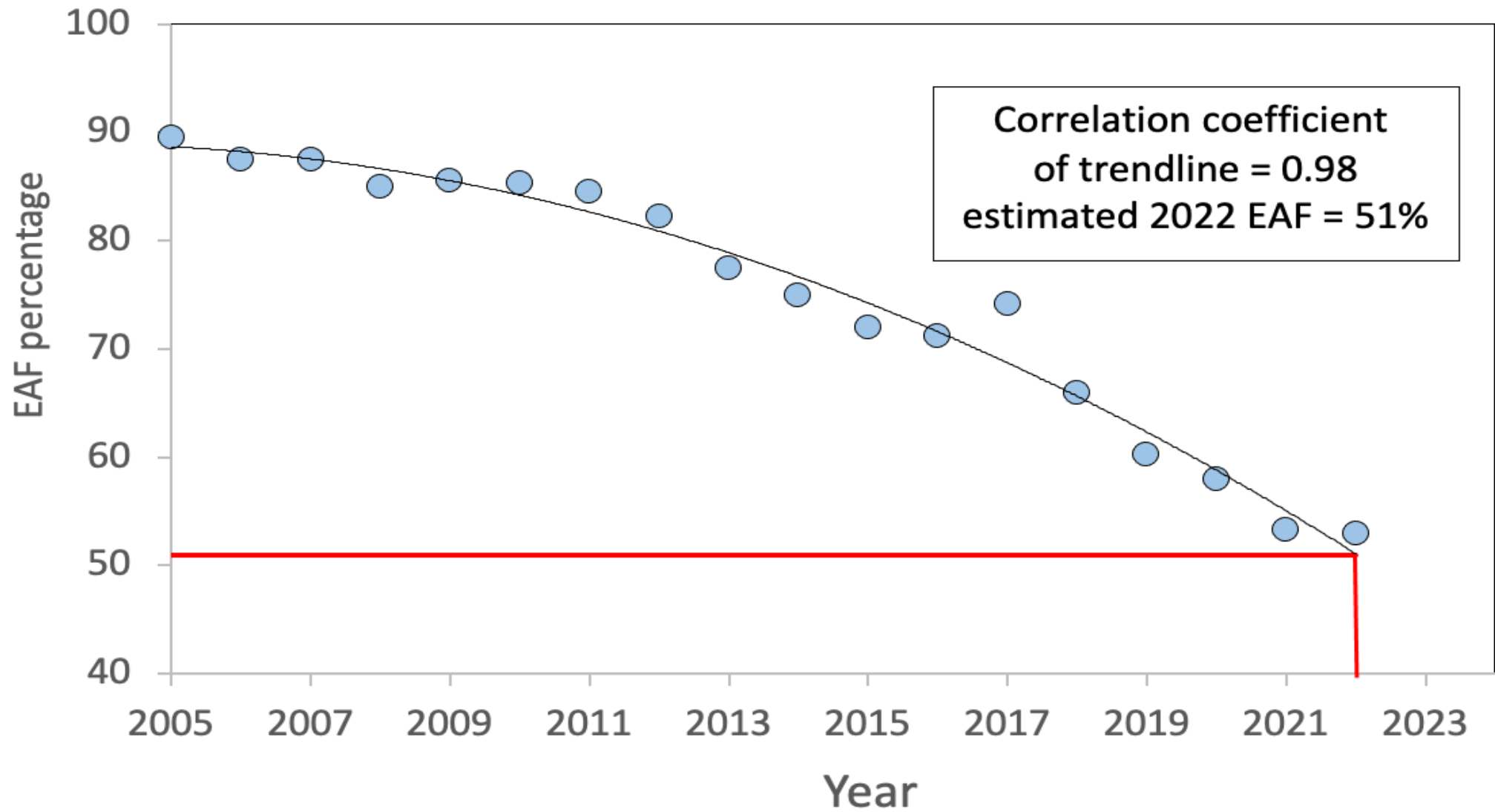
⁷ Source: <https://www.reuters.com/article/safrica-eskom-idUSL1N2PO1EQ>

⁸ As of July 15, 2021. Source: [0220715 Coal stations performance Jan 2021 to date Chris Yelland.xlsx](https://www.reuters.com/0220715%20Coal%20stations%20performance%20Jan%202021%20to%20date%20Chris%20Yelland.xlsx)

20s/30s – low EAF* 14.4 GW **Late 30s – High EAF 10.9 GW**
 * Matla/Camden – upper 50s **Late 30s – low EAF 7.3 GW**
New 5.7 GW

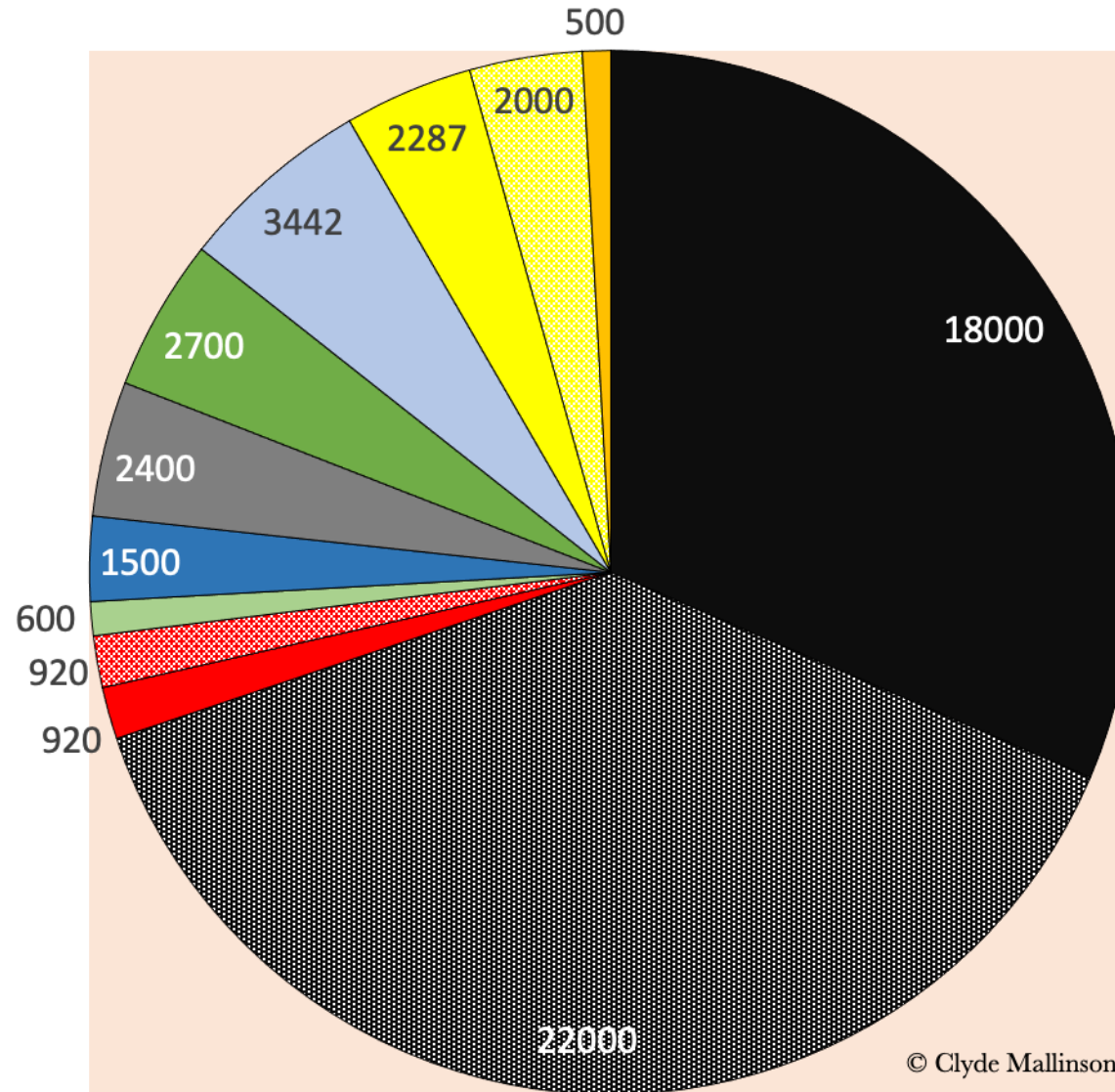
Eskom coal fleet EAF

2005-2022



South Africa, 2023: Energy generation nominal installed capacity

Source: Clyde Mallison



© Clyde Mallinson

- Coal: working
- Coal: not working
- Nuclear: working
- Nuclear: not working
- Hydo
- Imported Hydro
- OCGT
- Pumped storage
- Wind
- Utility Solar PV
- Rooftop Solar PV
- CSP

	2007	2019
Employee costs (billion rand)	9.5	33.3
Employees	32 674	46 665
Coal costs (billion rand)	10	58.5
Coal purchases (Mt)	117.4	118.3
Electricity sales (GWh)	218 120	208 319
Total installed capacity (MW)	42 618	44 127
Revenue (billion rand)	39.4	179.9
Ave selling price (c/kWh)	18	90.01
Debt (billion rand)	40.5	440.6

(Source: Bloomberg)

4 TURNING POINTS

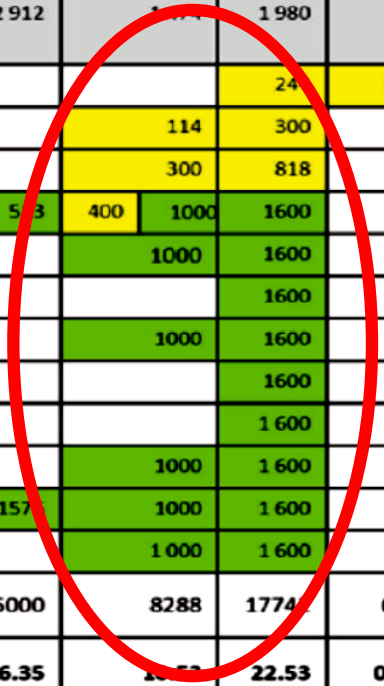
- 1998: Energy White Paper recommends urgent new coal build – ignored until Mbeki apology in 2007, rush to build Medupi & Kusile
- 2015: Eskom CEOs - Koko & Molefe - refuse to sign REIPPPP PPAs – 5 GW, would have removed 95% of loadshedding
- 2019: Minister Mantashe refuses to open a bid window until IRP is published (end 2019) – commissioning 5 GW in 2019 would have removed a lot of loadshedding today
- 2023: Budget Speech – new vision for Eskom as a transmission company and appointment of Minister of Electricity (champions the Energy Action Plan compiled after July 2022 Presidential statement)

Table 5: IRP 2019

	Coal	Coal (Decommissioning)	Nuclear	Hydro	Storage	PV	Wind	CSP	Gas & Diesel	Other (Distributed Generation, CoGen, Biomass, Landfill)	
Current Base	37 149		1 860	2 100	2 912	1 174	1 980	300	3 830	499	
2019	2 155	-2373					24	300		Allocation to the extent of the short term capacity and energy gap.	
2020		-557				114	300				
2021	1 433	-1403				300	818				
2022	711	-844			5 3	400	1000	1600			
2023	750	-555				1000	1600		500		
2024			1860				1600		1000		500
2025						1000	1600				500
2026		-1219					1600				500
2027	750	-847					1 600		2000		500
2028		-475				1000	1 600				500
2029		-1694			157	1000	1 600			500	
2030		-1050		2 500		1 000	1 600			500	
TOTAL INSTALLED CAPACITY by 2030 (MW)		33364	1860	4600	5000	8288	1774	600	6380		
% Total Installed Capacity (% of MW)		43	2.36	5.84	6.35	21.52	22.53	0.76	8.1		
% Annual Energy Contribution (% of MWh)		58.8	4.5	8.4	1.2*	6.3	17.8	0.6	1.3		

11 GW decommissioned by 2030

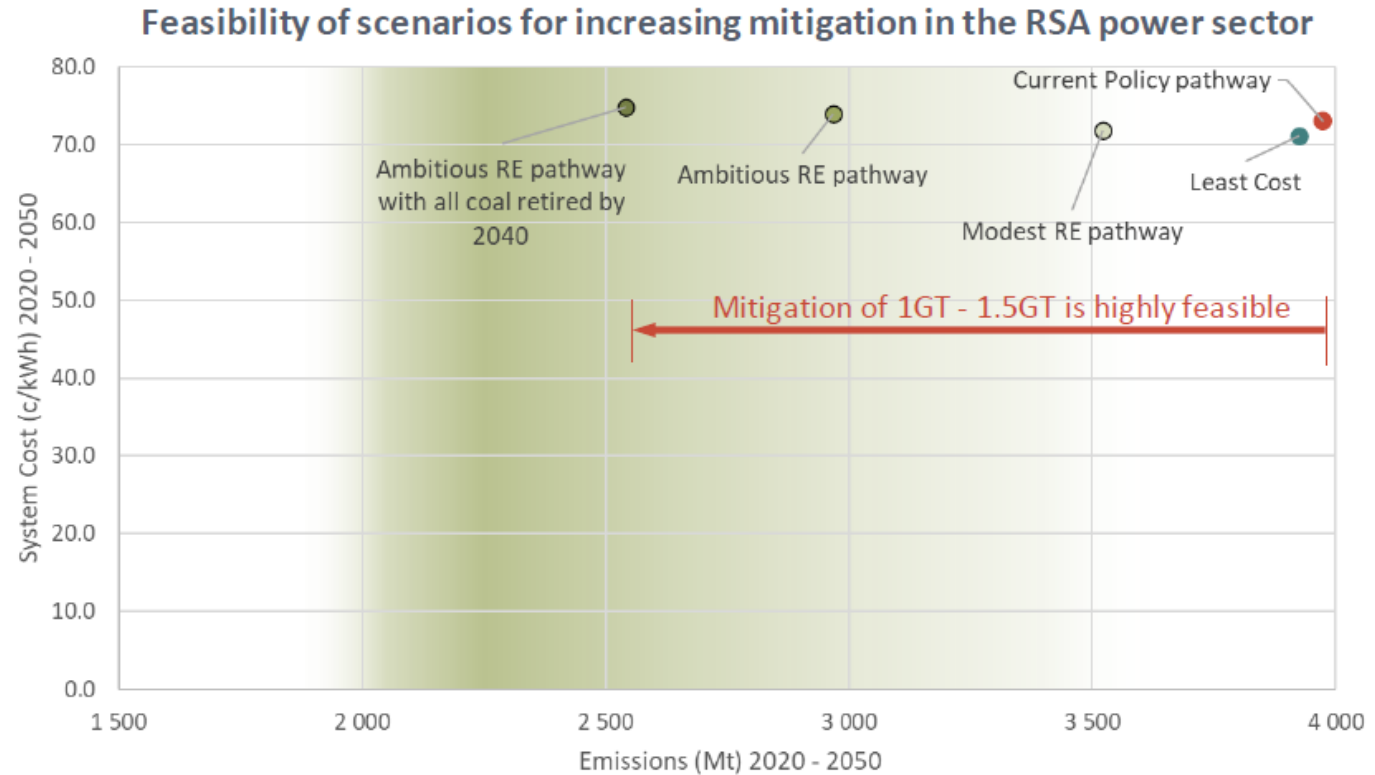
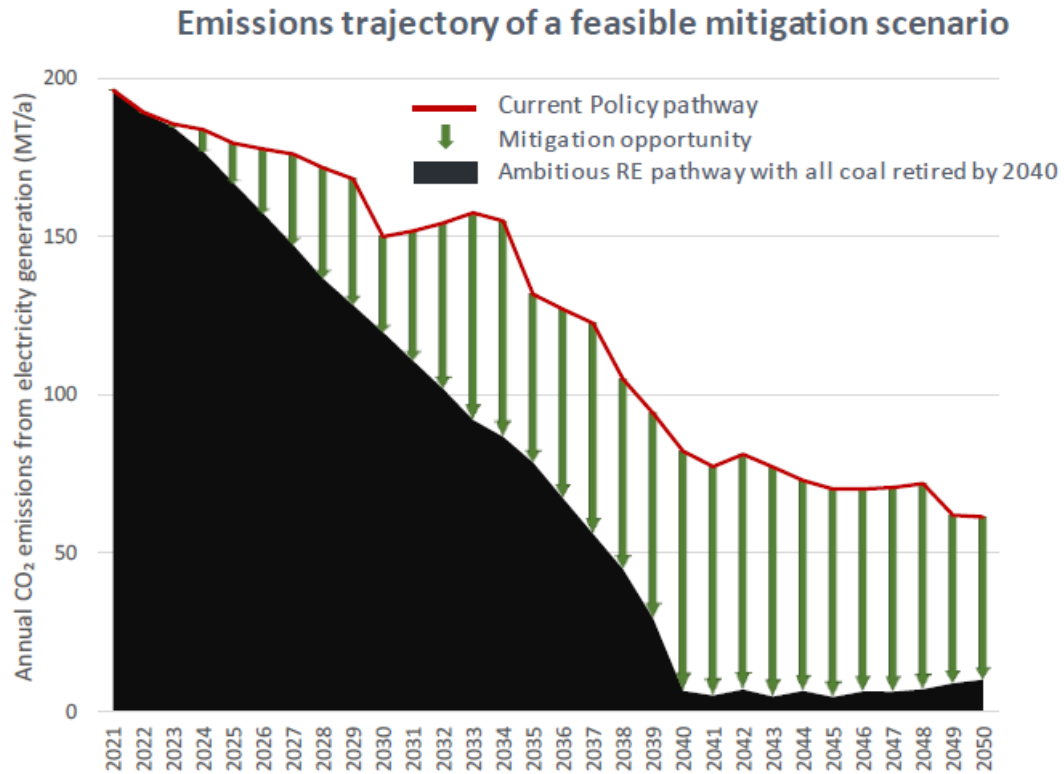
New goal – 1.5 GW – won't happen, unfundable



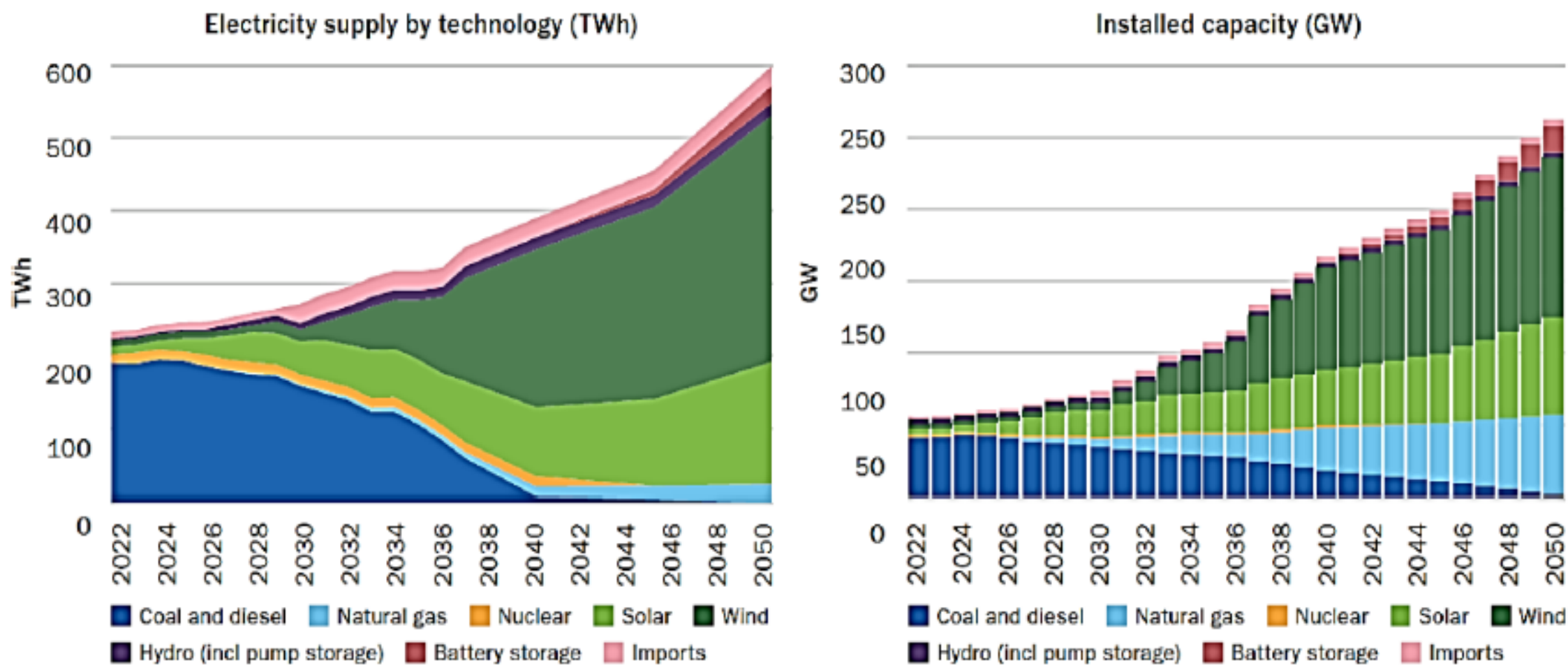
- Installed Capacity
- Committed / Already Contracted Capacity
- Capacity Decommissioned
- New Additional Capacity
- Extension of Koeberg Plant Design Life
- Includes Distributed Generation Capacity for own use

6 GW 14.4 GW

LEAST COST PATHWAY TO ENERGY SECURITY – COAL CLOSURE MINUS 2 POWER STATIONS



- SA's power sector can avoid 1.4Gt of CO₂ emissions against a BAU reference case of 3.9Gt CO₂ emissions from 2020-2050
- New renewables is the least cost option for SA to satisfy demand - cheaper than refurbishing old coal power stations. The recently published National Infrastructure Plan commits SA to the least-cost pathway, which is expected to be reflected in an updated IRP

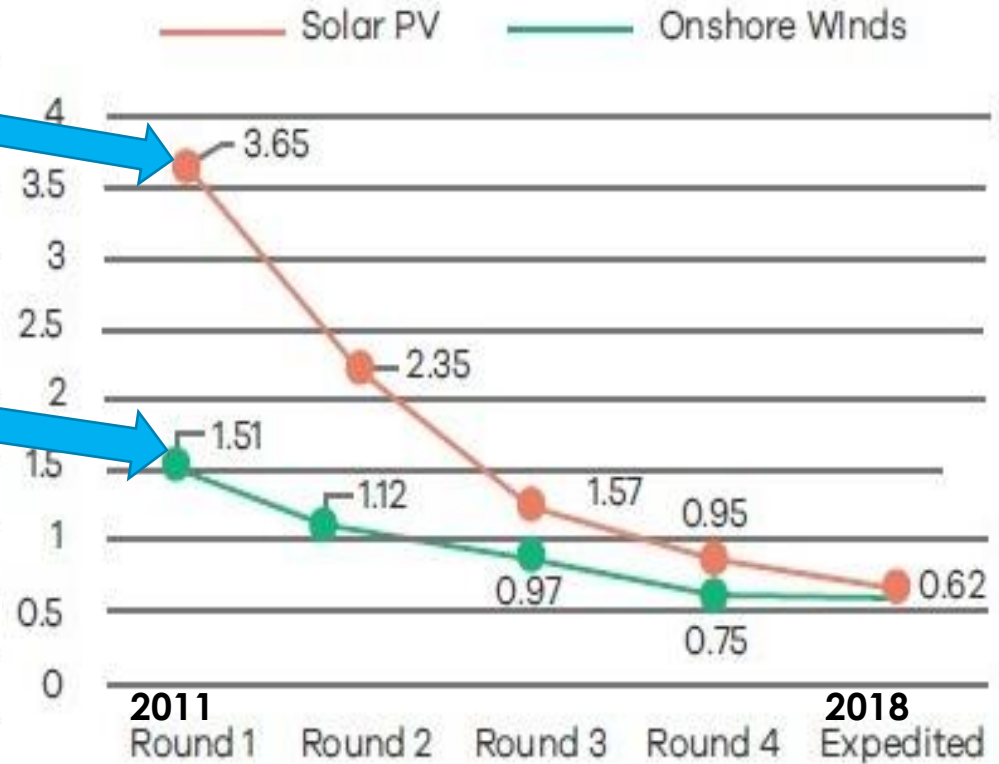
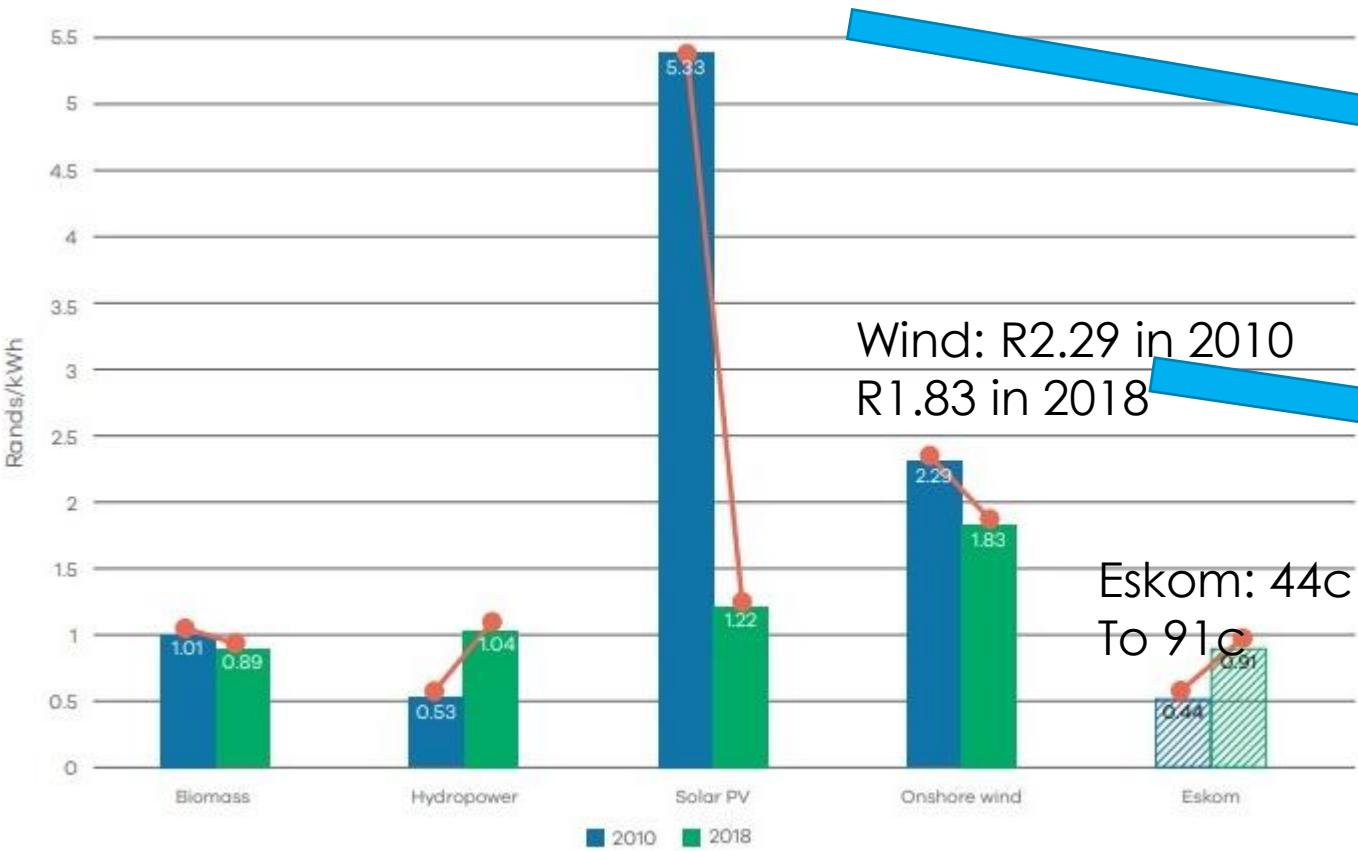


Source: SATIM

FIGURE 7: NET ZERO REFERENCE SCENARIO FOR THE ELECTRICITY SECTOR BY ELECTRICITY SUPPLY TECHNOLOGY (TWh) AND INSTALLED CAPACITY (GW)⁶⁰

Solar: R5.33 c in 2010
R1.22 in 2018

BWs 1 & 2: too high – ave cost spread
across BWs 1-4



Wind: R2.29 in 2010
R1.83 in 2018

Eskom: 44c
To 91c

Figure 4: International levelised cost of electricity (LCOE) per renewable energy technology, and Eskom average tariff trajectory 2010-2018 (Rand/kWh)

Source: Adapted from IRENA (2019)²

(GreenCape 2018)

Today's prices (2020):
Wind: R0.66
Solar PV: R0.60
Nuclear: R1.76
Coal: R1.31
OCGT: R5.30 (10% capacity)
OCGT: R1.57 (50% capacity)



**national planning
commission**

Department:
The Presidency
REPUBLIC OF SOUTH AFRICA

NPC PROPOSES URGENT MEASURES TO END LOADSHEDDING CRISIS 6 July 2022

- **10 GW of new generation capacity could end load-shedding in 2 years – NECCOM plan approved**
- **Implement the following:**
 - **Remove the 100 MW ceiling on embedded generation projects**
 - **Streamline NERSA processes**
 - **Streamline environmental and water approvals**
 - **Temporary exemption from local content requirements**

ENERGY ACTION PLAN

SIX MONTH UPDATE: JANUARY 2023

Key achievements updated to 2023:

- Schedule 2 of the ERA amended to remove licensing requirements
- Ministerial Determination in August 2022 for 14 GW of wind, solar and battery storage
- Bid Windows 7 and 8 announced – 5 GW each
- Enabling Municipalities to procure from IPPs
- Private sector embedded generation projects now at 9 GW from 100 projects
- 25 projects from Bid Windows 5 and 6 will deliver 2.8 GW
- 300 MW procured from SA power pool
- Eskom's Standard Offer programme to procure 1 GW
- Various actions to fix the power stations and ensure effective security
- Various efficiencies introduced to fast track environmental authorisations, Nersa registrations, grid connection authorisations, and land-use authorisations

National Electricity Crisis Committee – responsibility of Minister of Electricity. His focus is fix what can be fixed, and extend life where possible (but with no extra funding), 15 GW of renewables, gas and battery backup, upgrade the transmission grid, municipal procurement, energy efficiency, limit Karpowership contract to 5 years.

BUDGET SPEECH

- “We are proposing a total debt-relief arrangement for Eskom of R254 billion”
- “These conditions include: Requiring Eskom to prioritise capital expenditure in transmission and distribution during the debt-relief period.”
- As far as power stations are concerned, fix what can be fixed, sell what can be sold, and close what needs to close.

This effectively means that debt servicing will not come from normal cash flows. Maintenance to fix the machines must come from these cash flows and not from the equity injection from the state.

In short, the future of Eskom is not generation, but transmission and distribution. Hence the priority to set up the NTCSA.



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BETTER FINANCE, BETTER GRID

Mobilising capital to scale transmission grid capacity in South Africa to improve energy security, create jobs and support inclusive growth

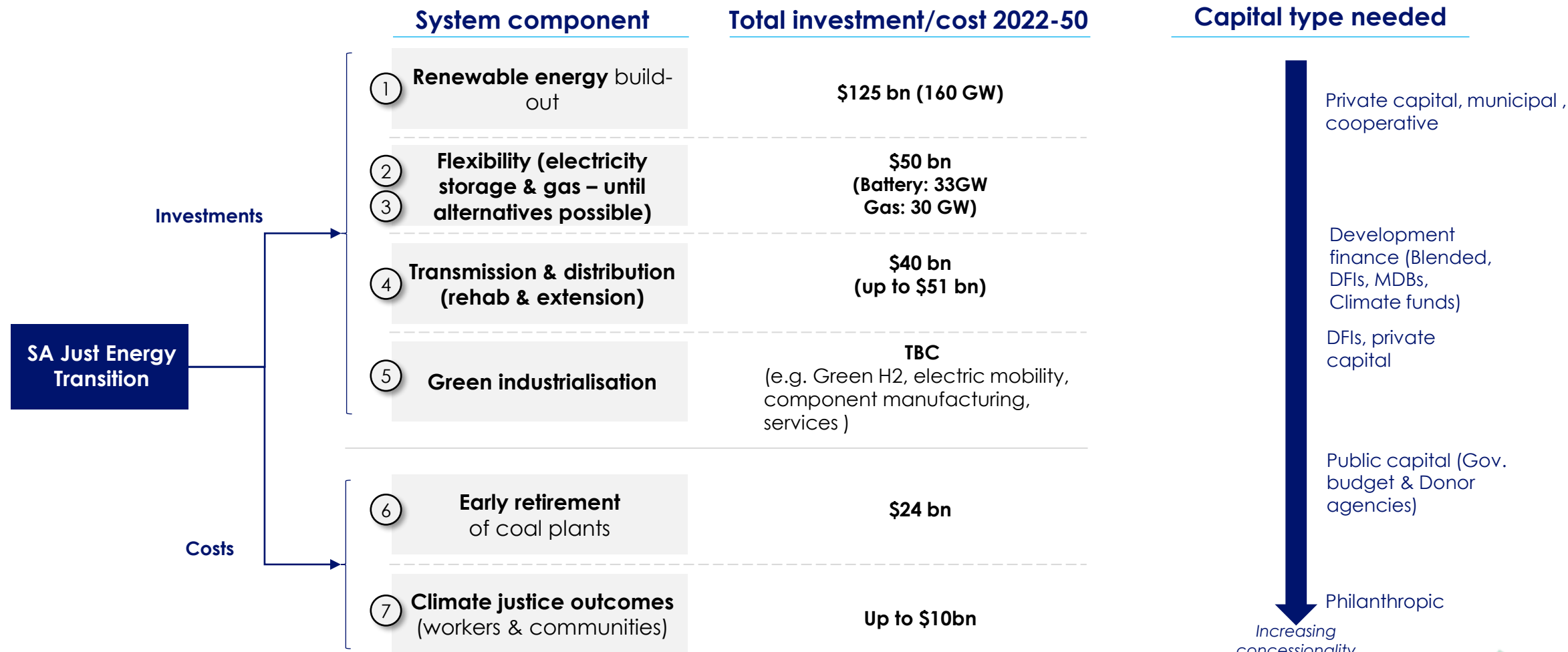
2023



With thanks to



IT WILL TAKE AT LEAST \$250BN SPENT OVER THE NEXT THREE DECADES TO TRANSITION TO A LOW-CARBON, MORE EQUITABLE ENERGY SYSTEM



17 [1] The majority of catalytic capital will need to be frontloaded and so deployed in the first decade of the transition. Under an ambitious coal off by 2040 scenario, the majority of the renewable energy infrastructure will need to be in place before then.

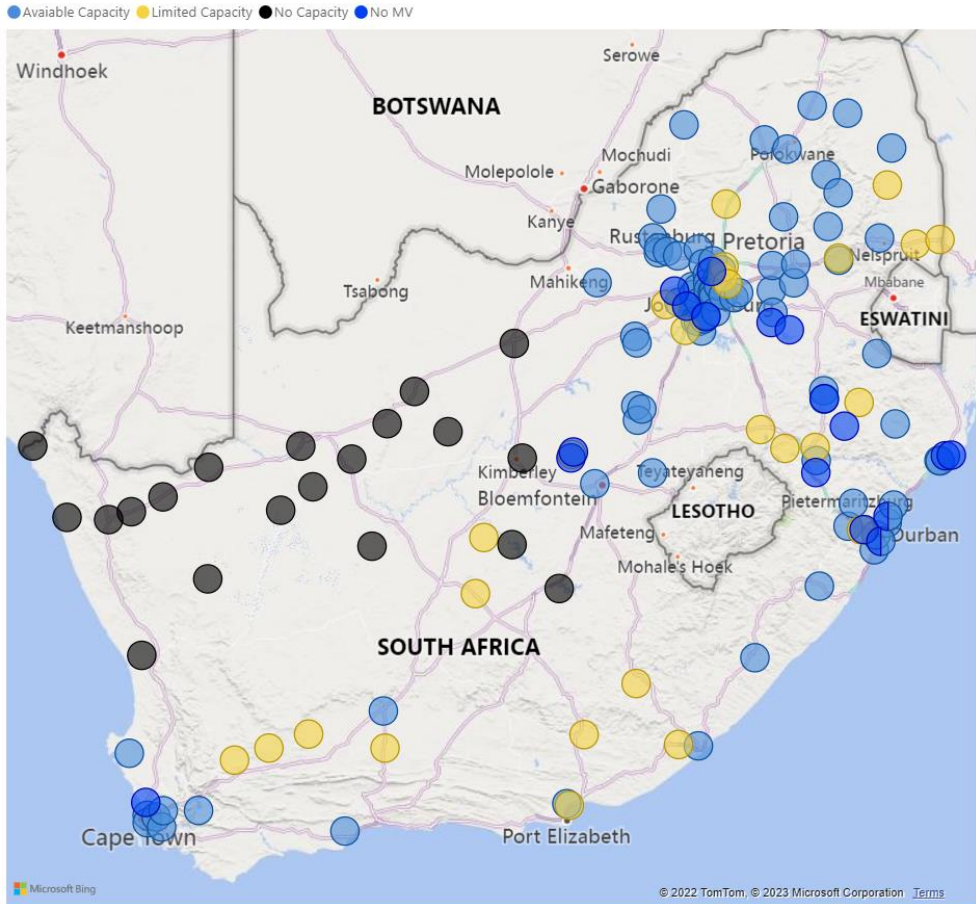
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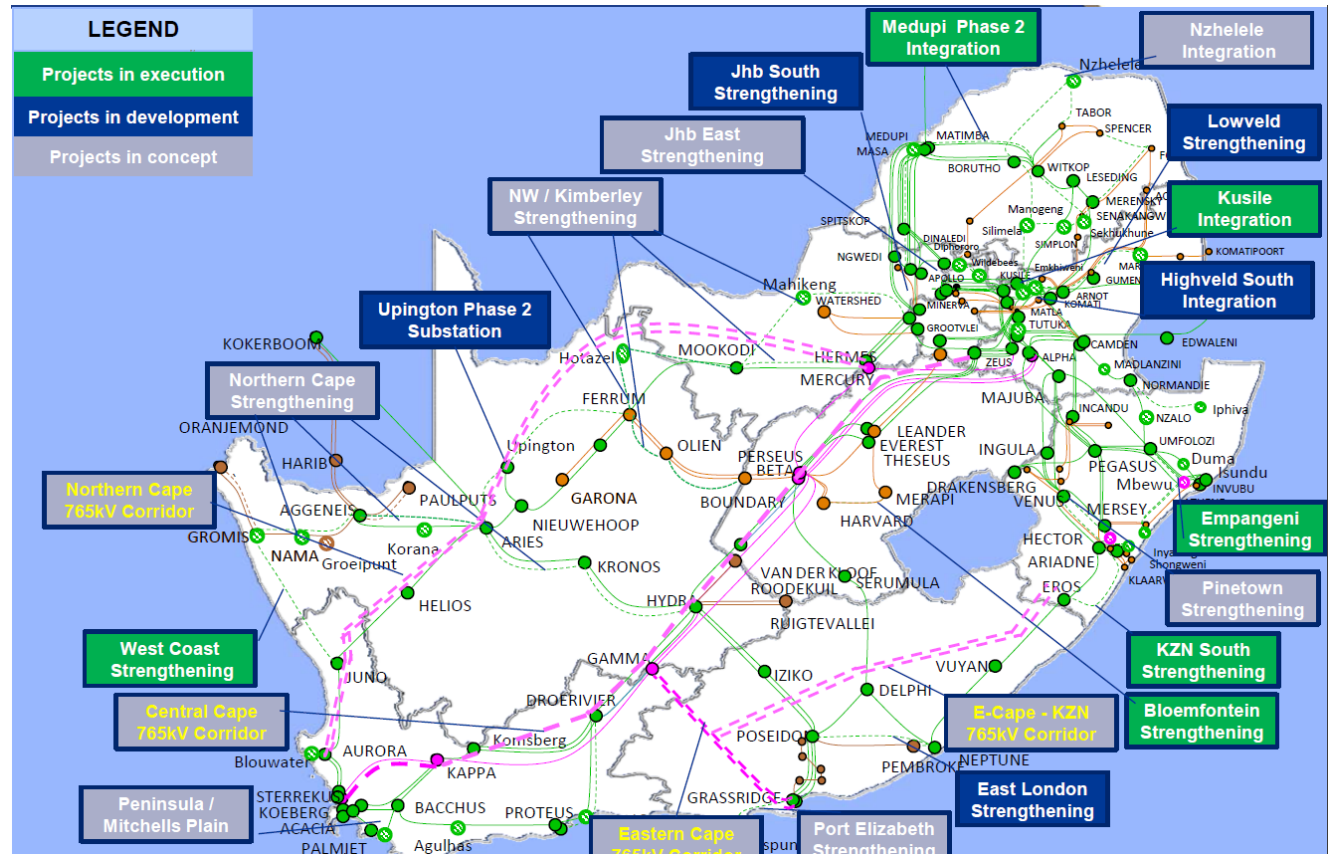
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SHORT-TERM OPTIMISATION AND LONG-TERM TRANSMISSION INFRASTRUCTURE OPPORTUNITIES

Capacity that could be unlocked in the short-term through targeted investments in transformers






Long-term investments needed in northern, central and southern corridors



NEED TO BUILD 1500 KMS PER ANNUM FOR THE NEXT 20 YEARS – CURRENT RATE IS 400 KMS. URGENT NEED TO RAMP UP FAST, NOW. MINISTER IS ONTO THIS.

THERE ARE AREAS WHERE THERE ARE CABLES, BUT NOT SUB-STATIONS – W CAPE (1.8 GW), FREE STATE (2.3 GW), NORTH WEST (3.8 GW) AND MPUMALANGA (5.1 GW) – LOW HANGING FRUIT IS, THEREFORE, RAPID ROLLOUT OF SUB-STATIONS.

Overhead lines and transformer capacity required to facilitate + 53 GW of capacity by 2032

	 Transformer Capacity	 KM of Overhead Lines	 Cost Estimate
2023-2027	27 GVA	2893 km	48 bn ZAR
2028-2032	79 GVA	11325 km	~187 bn ZAR
Total	106 GVA	14218 km	~235 bn ZAR

Average yearly rate of transmission line build-out

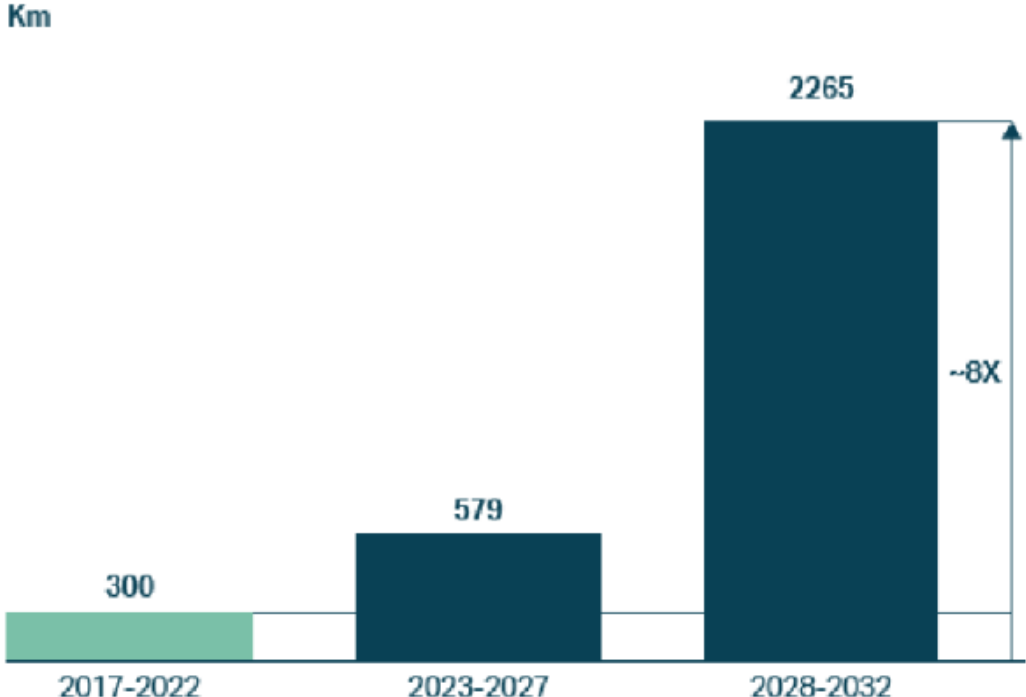
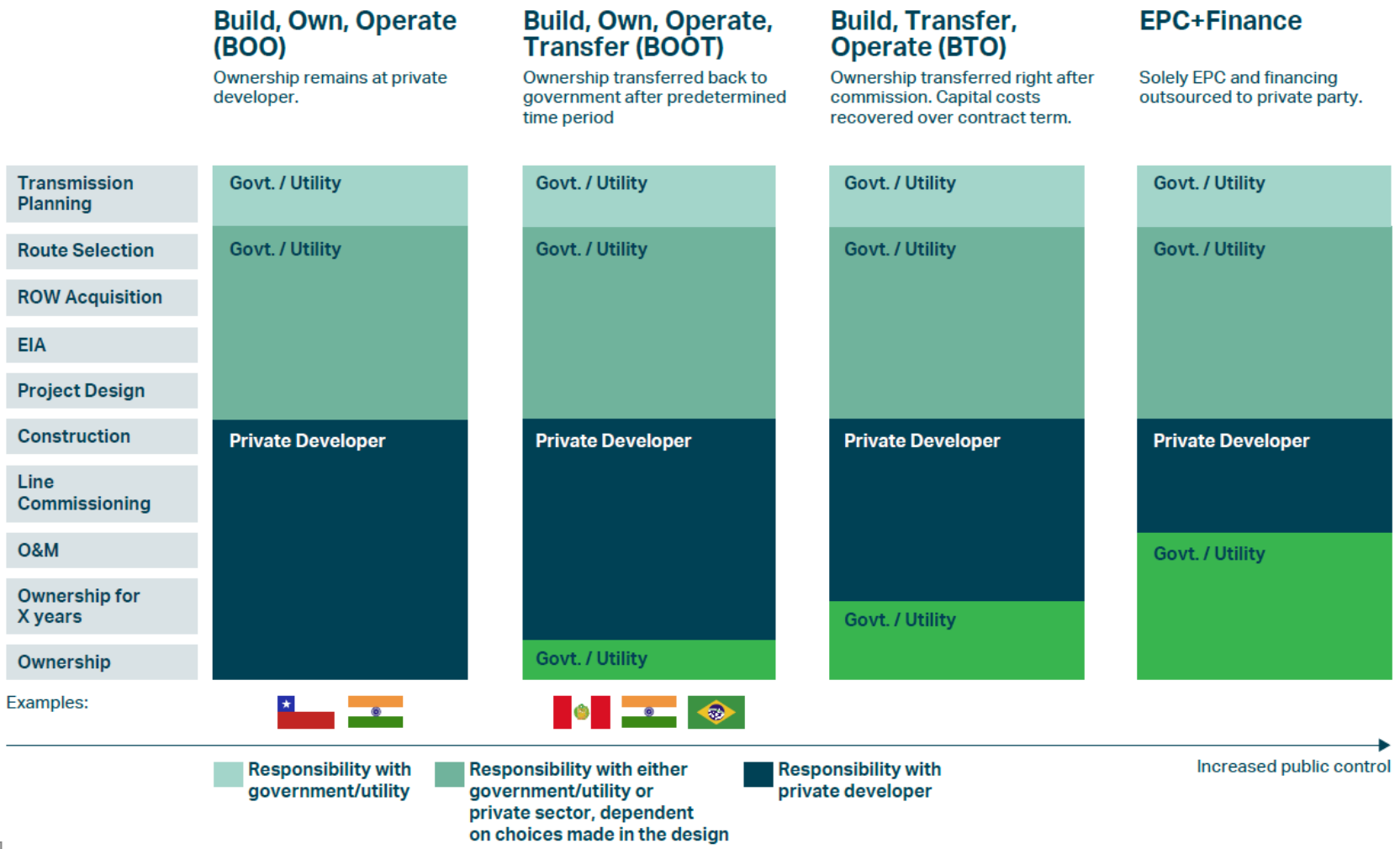





Figure 9: Required transmission line build rates 2023-2032, based on Eskom’s TDP

Independent transmission Projects (ITPs) likely most successful to finance transmission grid infrastructure in the short term

Various ITP models are possible: government/utility can pick desired control and ownership level



Amount of Independent Transmission Projects auctioned

-  70,000 km
 Brazil
-  6,000 km
 Peru
-  21,000 km
 India
-  >1,200 km
 Chile

Potential for significant cost reductions – for example Peru: 36% cost reduction

CONCLUSION

- Led by Minister of Electricity, for the first time we have an Energy Action Plan and real transparency
- 2023 will be the worst year of loadshedding – it already is, but as RE come on line (10 GW) loadshedding ends by end 2024
- Urgent priority is establishment of NTCSA and roll out of sub-stations where there are cables, and start of long-term transmission strategy
- The large bulk of the funding must be raised internally – R1.5 trillion until 2028, of which only R150 bn is from external sources
- Without the energy transition, rapid economic growth and therefore reduced unemployment is impossible
- Just Transition must become a core focus of work in Mpumalanga, which is what the Provincial Government is now prioritising