BETTER FINANCE, BETTER GRID

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

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BLENDED FINANCE TASKFORCE

CST Centre for Sustainability Transitions

CENTRE FOR RENEWABLE & SUSTAINABLE ENERGY STUDIES

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ABOUT THIS **CONSULTATION PAPER**

This consultation paper has been developed by the Blended Finance Taskforce and the Centre for Sustainability Transitions at Stellenbosch University, with the generous support of the Open Society Foundations. Drawing on expert interviews and analysis, this paper helps identify critical priorities to strengthen energy security in South Africa – with a focus on accelerating the building of transmission infrastructure. It explains the challenges and proposes actions to aid decision-making.

We offer this paper as a consultation document, to foster engagement with key stakeholders on these critical issues and we welcome all comments and feedback.

Insights and recommendations are based on desktop research, expert interviews and consultation with key stakeholders. The lead authors of this paper are Professor Mark Swilling and Erica Johnson from the Centre for Sustainability Transitions (CST) at Stellenbosch University; Lara Depla, Jesse Hoffman and Jeroen Huisman from the Blended Finance Taskforce (BFT); and Professor Bernard Bekker from the Centre for Renewable and Sustainable Energy Studies (CRSES) at Stellenbosch University. With support and guidance from Katherine Stodulka and Mark Meldrum (Blended Finance Taskforce). Special thanks go to Rob Stephen (past President of CIGRE) for his advice and contributions and to the European Climate Foundation for their support of research of CST and CRSES.

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FOREWORD

Unlocking finance for a low carbon economy is one of the fastest ways to improve energy security, create jobs and support inclusive growth. South Africa currently has one of the most carbon-intensive energy systems in the world with 86% of the country's electricity coming from domestic coal-fired power. Energy insecurity is one of the major development challenges. Many people face over six hours a day without power due to rolling national blackouts. This reduces productivity and can negatively impact GDP by up to 5%. Unequal access to affordable, reliable electricity perpetuates existing inequalities.

Renewable electricity is the fastest and cheapest way to tackle these issues and increase energy security – providing more electricity generation capacity and a stable supply while decarbonising the economy. Scaling renewables is not only key to driving energy security but also critical to tackling unemployment and enabling new economic opportunities linked to green industry, especially electric vehicles, green hydrogen, circular mining and energy storage. This will require an intentional upskilling agenda and critical considerations to a just and orderly transition given the different geographic locations of current high-carbon jobs and future low-carbon jobs.

But the impact of accelerating the build out of renewable energy projects and the associated jobs potential is limited if these projects cannot be connected to the grid. Since the locations with the best wind and solar conditions are mostly in the south west and the largest share of electricity demand is in the north east, rapid expansion of the power grid is essential. Out of the last bid window for renewable generation projects, over 3 GW was not approved because the network of transmission lines, substations and distribution lines that deliver electricity from the location of generation to businesses and consumers ("the grid") are insufficient. This holds especially for the high-capacity, long-distance transmission lines and substations ("the transmission grid").

This paper argues that a targeted approach to strengthening the grid by frontloading finance for transmission infrastructure – could have an outsized impact on South Africa's just energy transition, helping scale the amount of generation capacity, creating jobs and tackling energy insecurity. It dives deeper into what is needed – and where and how this can be delivered effectively and equitably in the current investment landscape by unlocking barriers to capital for the transmission grid. Part of this should be an efficient and catalytic allocation of capital, including climate finance like the $8.5 billion pledged by rich countries for South Africa's Just Energy Transition. This could include concessional loans or development guarantees for investments in transmission infrastructure.

A feasible pathway to end load shedding before the end of the decade exists, but not without significant investment into the transmission grid. The pathway involves simultaneously optimising the use of available grid capacity and scaling the rate of building new transmission infrastructure. Building new transmission infrastructure tends to take at least 7-10 years from planning to commissioning to effective operation. Given that there is an immediate shortage of transmission infrastructure to connect new renewable generation, it is essential that all options to optimise the use of the current transmission grid are pursued as soon as possible. Simultaneously, the rate of building new transmission infrastructure needs to increase urgently to secure the ability to connect new generation capacity in future years. Options to unlock barriers to capital for the required investments as laid out in this paper will be essential enablers to achieve the required increase in build rate.

EXECUTIVE SUMMARY

Unlocking catalytic capital to strengthen the transmission grid is both critical and urgent to transition to a more secure and equitable power system. A national strategic programme of investment is needed to build and connect the renewable energy generation that is critical to energy security, job creation and low-carbon growth.

01 STATE OF PLAY

Load shedding and transmission build out challenges & opportunities

The ongoing load shedding crisis is fundamentally driven by a lack of sufficient, reliable generation capacity. In recent years, on average ~1.5 GW per year of capacity was built and connected to the grid while ~3.5 GW was lost due to decreasing performance and necessary decommissioning of existing coal plants. This results in the current structural shortfall of 4 to 6 GW in power generation capacity that drives the load shedding.

New transmission infrastructure is necessary to connect the ~4-5 GW per year of new renewable generation capacity required for energy security and low carbon growth. Based on Eskom's most recent Transmission Development Plan (TDP), 4-5 GW per year of new renewable generation needs to be built and connected to achieve a resilient and secure power system by the early 2030s. The renewables build and connect rate was ~0.7 GW per year in recent years. Currently, there is no capacity on the transmission grid to connect new renewable generation capacity without making (targeted) investments in infrastructure, for example in transformers.

This means the just energy transition is impossible without significant investment in transmission infrastructure. Without additional transmission infrastructure, power from new generation capacity cannot be transported from the location of generation to the location of use. Recent transmission infrastructure building rates are insufficient, leading to severe constraints in the ability to connect new generation capacity to the grid. Transmission infrastructure is not only needed for energy security but also essential to position South Africa as a future green industrial hub and can help create jobs across the country. Transmission infrastructure therefore indirectly enables new strategic (economic) options, such as in electric vehicles and green industries.

Urgent action is needed to drive a national investment approach to optimise the use of current transmission infrastructure and significantly increase the rate of building new transmission infrastructure. The transmission grid needs a significant increase in targeted and catalytic investment to facilitate a just energy transition by connecting new generation and dealing with increasing electricity demand. This means that unless institutions mobilise today, the transmission grid will become a blocker for energy security and low carbon growth.

02
OPTIMISING THE USE OF CURRENT TRANSMISSION CAPACITY

The only way to connect new generation capacity to the grid in the coming years is through optimising the use of the existing transmission infrastructure capacity. In the next four years about 16-20 GW of new renewable generation needs to be build and connected. Without investments, there is no capacity to connect new generation to the transmission grid in the south west of the country where solar and wind resources are the strongest. Across the country, about 17 GW of transmission capacity can be unlocked in the short-term through targeted investments in additional transformers. Most of this is in the north east where renewable generation conditions are moderately less favourable than in the south west. By contrast, solar resources in the north east are twice as abundant as solar resources in the Netherlands, the country with the most solar panels per capita in Europe.

There are roughly two avenues for optimising the use of existing transmission infrastructure. (1) Focus new generation projects in areas with existing transmission grid capacity and (2) Maximise the amount of generation capacity connected at any specific location. (1) Coordinated action can make sure that renewable generation projects are developed at those locations where transmission infrastructure is made available. This could fully leverage 17 GW of existing grid connection capacity, that can be unlocked through targeted investments in transformers. Projects at these locations of available grid capacity may come with a slightly higher (+10-15%) cost of generation, relative to projects sited in the best renewable resource locations. However, the cost of generation from these sites will still be measurably lower than the cost of electricity from new coal generation and will be faster to deploy. On top of the 17 GW, more could be unlocked by additional investments in transformers in regions where these are currently not planned. This holds only if suitable renewable generation locations can be found, for example in Kwazulu-Natal. Further potential comes from utilising decommissioning coal plant connections and increasing rooftop solar. (2) The design of new renewable projects should seek to fully utilise the transmission infrastructure and maximise the amount of electricity that flows through any available grid connection. Example actions to achieve this include co-locating wind and solar which generate at different times, overbuilding renewables to increase the amount of time they are generating as much electricity as the grid connection can carry, deploying batteries to create a more stable electricity supply through the connection and introducing voluntary curtailment to use grid capacity that cannot be guaranteed to be always fully available.

03
INCREASING THE NEW TRANSMISSION INFRASTRUCTURE BUILD RATE

Simultaneously, an 8 times faster build rate of new transmission infrastructure is needed to connect the full 53 GW generation capacity required for energy security until the early 2030s. Additional transmission infrastructure is needed to connect ~36 GW of (mostly renewable) new generating capacity before the early 2030s. To ensure sufficient connection capacity, the grid build rate needs to increase from ~300 to ~2,300 km per year. Even more is needed for new generation from 2030 – 2050 to meet power demand as existing coal plants retire according to plan and peak electricity demand continues to grow.

A national strategic program of investment, that builds on South Africa's unprecedented leadership to finance a just energy transition, can help overcome existing barriers to achieving the required transmission infrastructure build rate. At present Eskom is responsible for financing and building the transmission grid. These responsibilities are being transferred into a separate transmission company, wholly owned by Eskom. Eskom's current debt burden places constraints on the ability to attract sufficient capital for the transmission grid build out. Another barrier to address is timelines. Currently it takes 7-10 years from transmission infrastructure planning to execution; this needs to be done faster. Speeding up requires tackling planning & permitting processes (long timelines), workforce availability, and procurement procedures. Overcoming these barriers needs involvement of all key stakeholders and long-term commitments on where and how the transmission grid will evolve. This is needed to provide line of sight on work to the entire supply chain so companies can confidently invest now in scaling up. A national strategic program to overcome these barriers can build on existing plans such as the Just Energy Transition Investment Plan, Eskom's Transmission Development Plan, the forthcoming Integrated Resource Plan and the updated Energy Development Plan.

04
INVESTIGATING OPTIONS FOR SECURING THE REQUIRED CAPITAL

One of the key barriers is access to the ~235-372 bn ZAR (~$14-22 bn) of capital required to finance new transmission infrastructure in the coming 10-12 years. The required funding to strengthen the transmission grid over the next decade, is close to Eskom's current debt levels of ~390 bn ZAR. Constraints on attracting the required capital will likely remain, even with the new transmission company and after the announced Eskom debt take-over by government. There is a need to explore additional avenues to attract and deploy sufficient capital, including avenues that finance transmission off the transmission company's balance sheet.

Alternative models for financing the transmission infrastructure off Eskom's balance sheet can help increase access to the necessary capital. Even though publicly owned utilities with healthy balance sheets can finance infrastructure on balance sheet, many still use other financing structures for all or some of their infrastructure. Several case studies show that these projects can lead to reductions in transmission cost and that off-balance sheet project financing is possible within many different regulatory frameworks. This includes models that cater to different levels of desired ownership, control and of private sector involvement.

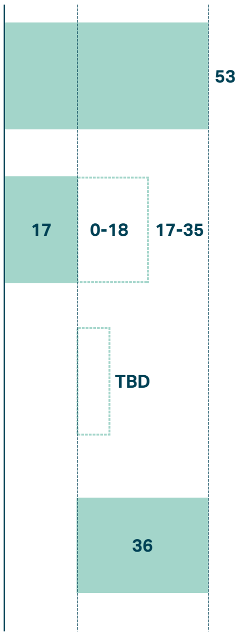
Independent Transmission Projects (ITPs) are likely the most successful model for how Eskom can achieve off-balance sheet financing needs for new transmission infrastructure. ITPs are a proven model in several emerging markets including Brazil, India, Peru and Kenya. They can be conducted for selected projects, allow for flexibility and require relatively limited regulatory changes. Case studies also show that ITPs can unlock investment, mitigate perceived risk and achieve cost savings of 35-40%. ITPs allow for different forms of ownership and control structures by the transmission company. At a minimum, the transmission company would be in charge of selecting and designing projects that are suitable for ITPs and tendering those. Finally, Eskom already has experience with Independent Power Producers (IPPs), a system that has many similarities with ITPs.

Catalytic allocation of public capital can play a crucial role in financing new transmission infrastructure and enabling a pathway to a more secure and equitable power system. Through project finance structures such as ITPs, capital can be unlocked for building, maintaining and/or operating transmission assets. To reduce the cost of capital for such projects, some risks need to be addressed, especially on long-term revenue stability. Concessional loans or development guarantees to ITPs would help mitigate certain timing and investment risks to lower the cost of capital. International climate finance like the $8.5 billion pledged by rich countries for the Just Energy transition under the "JETP" could be one source of this catalytic funding, deployed through development banks like the DBSA and the AfDB.

Transmission grid capacity required for energy security

Lower bound
Range

Chapter | **GW** | **Explanation**



01
Required grid capacity for connecting new generation capacity until early 2030s

- **Solve today:** 6 GW to close **current supply gap.**
- **Solve tomorrow:** + 10GW to replace **decommissioning coal plants** + 6 GW to compensate for decreasing performance of **existing coal plants** + 8 GW for **growing energy demand.**
- **Adjustment:** 23 GW adjustment to account for lower average utilisation of renewable generation capacity (due to weather conditions) compared to coal plants.

02
Optimising the use of current transmission capacity

2.A
Focus new renewable projects in areas with available grid connection capacity

- 17GW of current **capacity planned to be unlocked by new transformers.** Capacity is mostly in locations slightly less favourable to renewables, though only ~10-15% higher generation cost vs best locations and renewables in these locations are still lower cost than new coal.
- Additional potential to be further quantified and confirmed: [a] up to 10 GW of **connection capacity at decommissioning coal plants;** [b] up to 8 GW of **rooftop solar potential**.

2.B
Maximise the amount of generation capacity connected at any specific location

Solutions to be quantified through further location-based research:
- **Co-locate** solar and wind
- **Oversize** capacity of renewable generation (solar & wind)
- Use **batteries** to shift renewable generation in time
- Include **voluntary curtailment**

03
Increasing the new transmission infrastructure build rate

- New transmission infrastructure needed to connect >60% of generation capacity, exact amount dependent on outcomes of further optimisation of current transmission capacity (2)
- Requires an **8 times increase in build rates from 300 km/y to >2,000 km/y** in second half of the decade
- National strategic program needed to reduce 7-10 planning & building timeframe, aimed at overcoming four key barriers: Planning & permitting hurdles, Procurement of materials, Qualified workforce availability and access to sufficient capital (see below).

04
Securing the required capital

- **Investments of ~235-372 bn ZAR likely required until 2035,** the debt currently on Eskom's balance sheet is ~390 bn ZAR
- Based on case studies, methods for **financing off the transmission utility balance sheet** are possible. Beyond mobilising capital, these solutions could also achieve significant cost reductions of 35-40%.
- **Independent transmission Projects (ITPs)** seem the most likely candidate in the short term. These have a proven track record in other emerging economies such as Brazil, India and Kenya, can be implemented on specific projects, require relatively little regulatory reform and can be tailored to the desired ownership and control of the transmission company
- **An efficient and catalytic allocation of public capital** could help accelerate the build out of South Africa's transmission infrastructure by lowering the cost of capital. This could include concessional loans or development guarantees to ITPs which help mitigate certain timing and investment risks.

Figure 1: Summary of key insights

01
STATE OF PLAY

Load shedding and transmission build out challenges & opportunities

The year 2022 has seen continued and worsening load shedding. Load shedding, related to (unplanned) interruptions of power supply, is currently at crisis levels. The full year 2022 was the fourth consecutive record year of load shedding across the country. As of October 3rd 2022, ~30% of the hours in 2022 experienced load shedding[1]. The situation only got worse in the final months of the year. The President commented that the load shedding crisis has caused immense damage to the economy and that the people are justifiably frustrated and angry.

The ongoing load shedding crisis is fundamentally driven by a lack of sufficient, reliable generation capacity. On average ~1.5 GW per year of generation capacity has been added to the system over the last 8 years, of which ~0.7 renewable[2]. In contrast, total generation capacity has reduced by ~3.5 GW per year over the last 5 years[3].

Together, this has created a shortfall in generation capacity. The loss in capacity consists mostly of planned and necessary decommissioning of old coal plants, but also decreasing performance of units that remain in operation. Approximately 12 GW of coal generation capacity has been effectively lost since 2013 due to decreasing effective operating capacity of existing coal plants, as displayed in figure 1. The effective generation time of plants is captured in the Energy Availability Factor (EAF), which refers to the difference between the maximum availability and all unavailability in a year expressed as a percentage[4]. The total (including all types of generation) EAF is estimated to be ~59% for April – October 2022[5] and only just above 50% when looking at coal generation capacity only[6]. The overall EAF has been decreasing by ~3% per year since 2013 based on Eskom reporting. This is mostly driven by an aging coal plant fleet with an average age of 41 years, inadequate maintenance, non-effective repair work and sabotage of plants. By comparison, an EAF of a healthy coal fleet is around 80%[7].

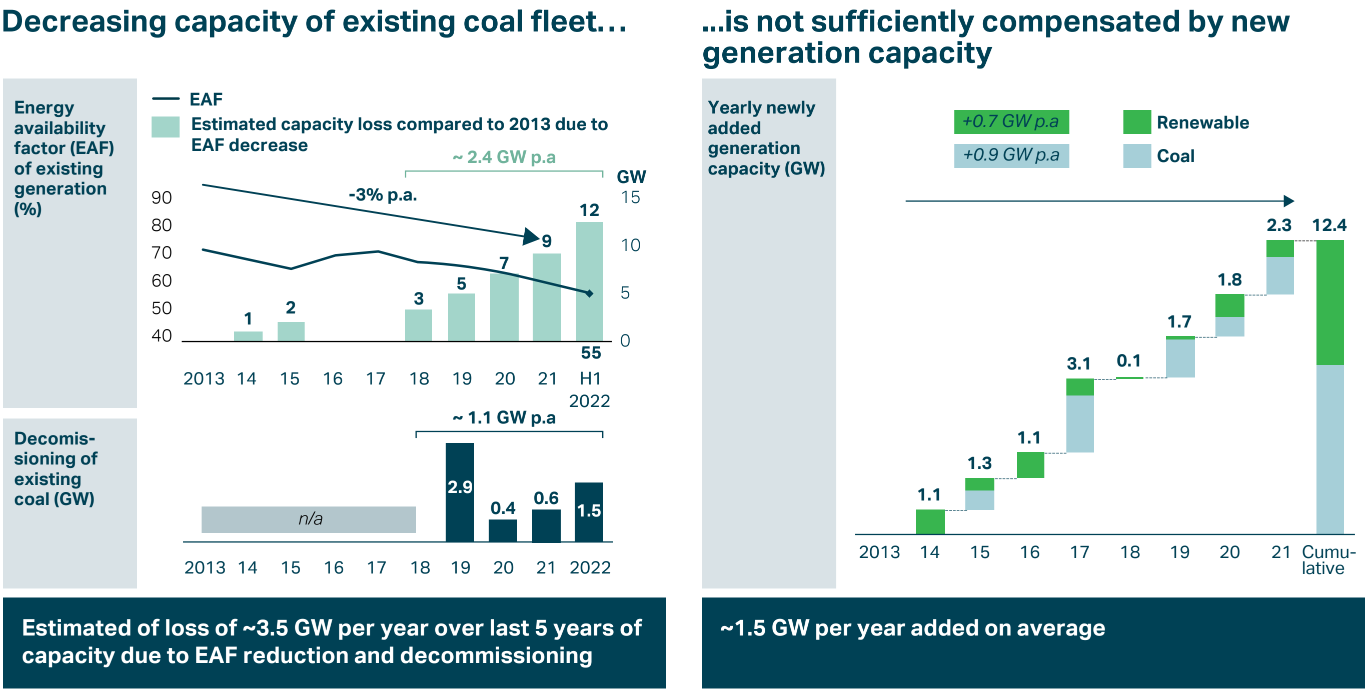


Figure 2: The decrease in electricity generation capacity versus the increase in coal and renewable generation capacity over the last years[i]

To achieve energy security by the early 2030s, 4-5 GW per year of renewable generation capacity needs to be built and connected. Eskom yearly updates and publishes its Transmission Development Plan (TDP) in which it outlines expected developments of power demand, electricity generation and plans for investment in current and new transmission infrastructure. Based on Eskom's most recent TDP, the current installed generation capacity amounts to 56 GW[8]. And an additional 53 GW of generation capacity needs to be built and connected to the grid by the early 2030s. This would result in an installed capacity of ~97 GW by 2032, including planned decommissioning of existing coal plants. These figures are higher than the proposed ~88 GW of installed generation capacity in the IRP 2019, but are more recent and updated in terms of developments over the last could of years.

The 53 GW of additional generation capacity implies an average build and connect rate of 5-6 GW per year. About 4-5 GW of this is renewables (including batteries), which implies a 6-7 times increase relative to the current build and connect rate of 0.7 GW per year. The amount of required capacity additions combines capacity needed to replace coal expected to go offline, close the current supply gap, cover the expected continuation of decreasing EAF, and satisfy energy demand growth (see also figure 3). This also means that if EAFs decrease further, more new (renewable) capacity may need to be built and connected to the grid.

i For the EAF Eskom reported data was used, which is based on its financial year that runs from April to March. For comparison purposes we have marked Eskom FY 13/14 as 2013, and likewise for the other years, since most of it falls in 2013

New capacity consists mostly of renewables, primarily because renewables are cheaper than coal per kWh sold. They do need more capacity to produce the same number of kWhs because renewables cannot operate on full capacity all the time, due to varying weather conditions. This means there is an adjustment required to translate these figures into relevant capacity volumes of renewables. This does not change the fact that for cost per kWh of electricity, renewables are still cheaper cost than new coal generation[9].

Indicative break-down of required capacity additions until early 2030s

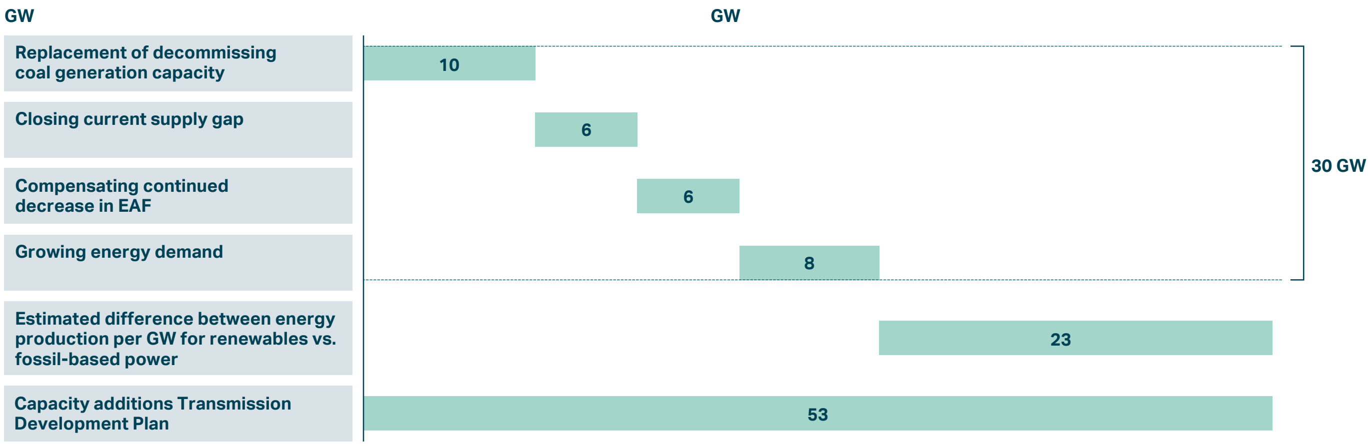


Figure 3: Estimated drivers for the required 53 GW of generation capacity needed for energy security [ii]

A focus on building generation capacity alone does not solve the load shedding crisis. Building new generation capacity only helps to solve the load shedding crisis if that capacity can also be connected to the grid. The grid refers to the network of transmission lines, substations and distribution lines that deliver electricity from the location of generation to businesses and consumers. The current lack of grid capacity especially holds for the high-capacity, long-distance transmission lines and substations ("the transmission grid"). Distribution lines ("the distribution grid") deliver electricity from the substations to the end-consumer's homes and businesses, and likely need less investment.

ii Assuming EAF will continue to decline at a slower rate of ~1% per year, 6 GW of capacity is needed to cover the reduced production of coal plants.

Renewable generation and transmission projects are often not developed in sync. Where renewable generation projects typically take 3-5 years, transmission infrastructure projects currently take 7-10 years. In practice, renewable generation capacity and the transmission grid are often not developed in sync. This is not a South Africa specific issue. Countries like the Netherlands also face issues in building the transmission grid and generation capacity at the same pace[10]. As in most other countries, the transmission infrastructure has been built based on conventional, fossil fuel, power plants. These are typically located close to where electricity demand is, or close to places with easy access to the required fuels. For example, coal plants located in the vicinity of the coal mining areas. This leads to two facets to the challenge in connecting the 53 GW of new renewable generation capacity to the transmission network:

- **There is a geographical mismatch between the existing transmission infrastructure and the most favourable locations to build renewables.** The transmission grid was historically built to transport electricity within the north east of the country, where the majority of electricity consumption and generation is located. Most renewable energy generation is expected in the south west, where solar and wind resources are most favourable (see figure 4).
- **The total transmission connection capacity is not sufficient to accommodate 53 GW of new generation.** Even if current transmission infrastructure is optimally used through targeted investments, there is insufficient grid capacity to connect the needed 53 GW of new generation capacity. Moreover, there is no grid capacity that is directly available without (targeted) investments. Chapter 2 further explains this.

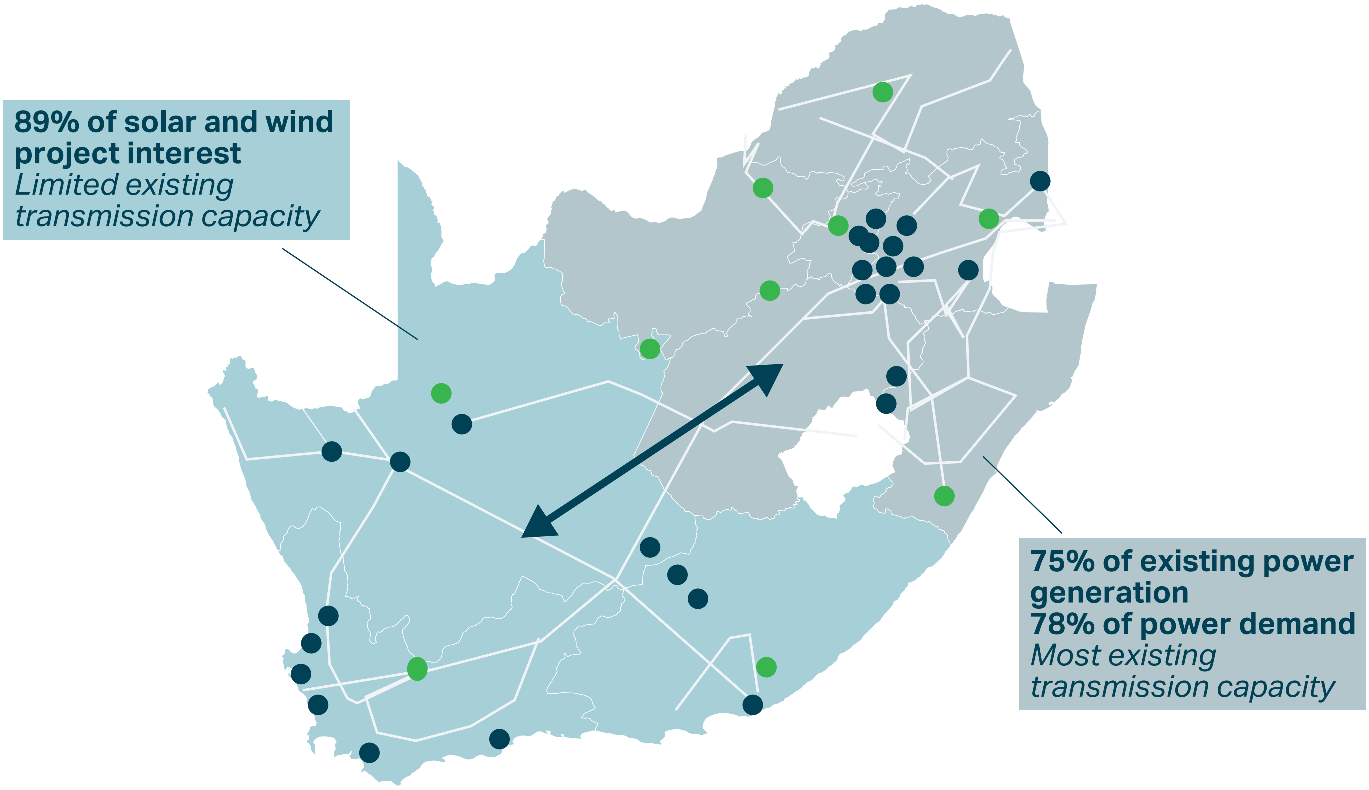


Figure 4: Geographical spread of current generation capacity, power demand, and solar & wind project interest [8]

The just energy transition is impossible without significant investment in transmission infrastructure. Without additional transmission infrastructure, power from new generation capacity cannot be transported from the location of generation to the location of use. Recent transmission infrastructure building rates are insufficient, leading to severe constraints in the ability to connect new generation capacity to the grid. Investments in the grid are also a key enabler for economic growth and jobs as the strategic priorities in the Just Energy Transition Investment Plan (JET IP) describe. The JET IP describes several vital sectors for decarbonisation: the Electricity, New Energy Vehicles and Green Hydrogen sectors[22]. A fit-for-purpose transmission grid is a key enabler for each of those:

- **The Electricity sector** is crucial to realise goals of energy security, decarbonisation and economic growth. Transmission infrastructure is an essential catalytic investment for the electricity sector – enabling the connection of renewables to the power system. This power system will also need to include storage. This is because of the higher variability of power generation through renewables, driven by weather conditions. Storage technologies will include batteries and pumped hydro storage.

- **New Energy Vehicles (NEVs)** can accelerate the decarbonisation of the transport sector and support healthier and more equitable cities. Due to NEVs uptake, power demand is expected to increase, requiring additional transmission infrastructure.

- **Green Hydrogen** production can ensure that the strong renewable potential in Northern Cape is further used to create economic value. Transmission grid connections are not a necessity for large-scale green hydrogen production projects. These projects will typically include building additional, dedicated renewable generation capacity to produce hydrogen and will thus not source power from the grid. However, these projects will have excess otherwise curtailed and thus very low-cost electricity11. A transmission connection can allow feeding this electricity into the grid, benefitting electricity buyers. Accessing such low-cost power will also be possible from green hydrogen projects just across the border in Namibia's southern corridor, see case study below.

Case study: Importing power from Namibia

South Africa could import significant amounts of cheap renewable power from Namibia if the right transmission infrastructure is in place. The Namibian government is pursuing a strategy for the development of large-scale green hydrogen & ammonia projects in the Karas region, which is directly across the border from South Africa's Northern Cape. Cheap renewable excess power will emerge from these projects. The large-scale green hydrogen projects in the Karas region collectively stand to export as much as 12 GW of low-cost power once fully developed.

Transmission lines would need to connect Namibia with the Northern Cape, and to connect the Northern Cape with South Africa's major demand centres (mostly in the north east). Transmission lines to import excess power from Namibia could be well-suited to be financed under Independent Transmission Project models (see chapter 4), as they are separable from the rest of the grid.

Source: Systemiq (2022), Namibia's green hydrogen opportunity

Urgent action is needed to drive a national investment approach to optimise the use of current and significantly increase the rate of building new transmission infrastructure. The transmission grid needs a significant increase in targeted and catalytic investment to facilitate a just energy transition by connecting new generation capacity and dealing with increasing electricity demand. This means that unless (financial) institutions mobilise today, the transmission grid will become a blocker for energy security and low carbon growth.

As shown in figure 5, the grid connection capacity shortage over this decade may amount to ~36 GW. Major transmission projects currently take between 7-10 years from planning to completion. Therefore, chapter 2 explores options for short term optimisation of current transmission capacity. The magnitude and scale of the simultaneously required investments in building out the transmission grid and other barriers to overcome are outlined in Chapter 3. Chapter 4 further details options for securing the required capital.

Grid capacity shortage towards early 2030s

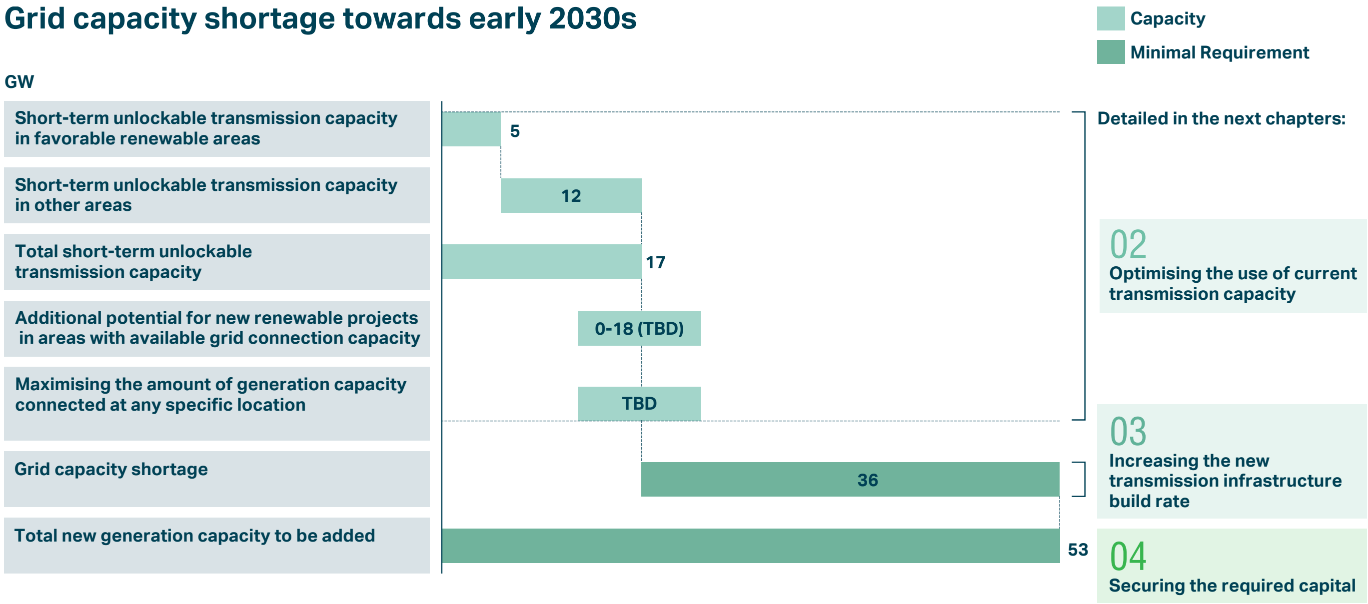


Figure 5: Location of grid capacity requirements towards early 2030s

02 OPTIMISING THE USE OF CURRENT TRANSMISSION CAPACITY

The only way to connect new generation capacity to the grid in the coming years is through optimising the use of the existing transmission infrastructure capacity. Based on an average 4-5GW of renewables to connect, 16-20 GW of new renewable generation needs to be built and connected to stay on a path towards energy security, decarbonisation goals and low carbon economic growth. Besides new renewable generation capacity, Eskom's Transmission Development Plan (TDP) includes additional new coal and gas-based generation. The current transmission infrastructure build rate cannot address the required rate of connecting new generation capacity fast enough and ramping up the grid build rate takes at least 3-4 years. It takes time to secure financing, to attain planning and permitting, and to scale up the procurement and workforce for new transmission infrastructure. It will take years before transmission infrastructure build rate rates are ramped up to the required levels.

Approximately 17 GW of transmission grid connection capacity can be unlocked in the short term through targeted investments. This connection capacity is mostly in the north east where renewable generation conditions are less favourable than in the south west. Based on Eskom's Generation Connection Capacity Assessment (GCCA) dashboard[12], there seems to be 32 GW of transmission connection capacity available in the current state[13]. However, the practical capacity is not the same as the theoretical capacity, as the TDP made clear[14]. Many locations are less suitable for building large scale (renewable) generation capacity, which has a significant spatial footprint. This holds especially for Limpopo, Gauteng and Kwazulu-Natal. Without these three provinces, there is ~19 GW of grid capacity. Targeted investments in transformers are needed to unlock this capacity. For ~17 GW of the 19 GW, concrete plans have been established for these investments[14]. Kwazulu-Natal would potentially have another ~6 GW of capacity if suitable locations for renewables development can be found. But further investment in transformers is needed to unlock this, which is not included in the current TDP.

Wind and solar project interest versus available grid capacity

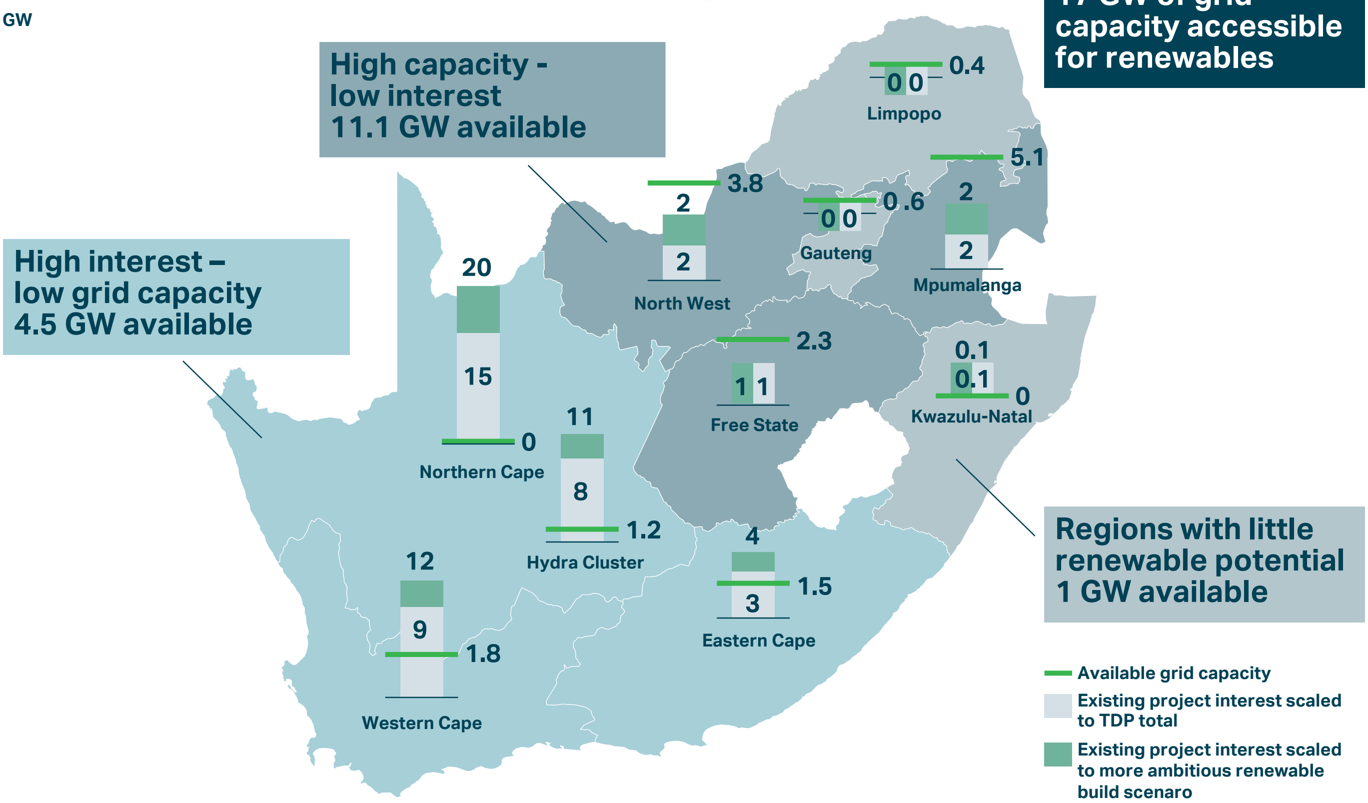


Figure 6: Wind and solar project interest towards early 2030s versus TDP included targeted investments for unlocking capacity at transmission level

Just ~5 of the 17 GW that is planned to be unlocked is situated in the south-west of the country where conditions for renewable projects are most favourable. Unsurprisingly, most interest from project developers is in the south west (see figure 6)[15]. In the most favourable region (Northern Cape), no grid capacity is available since Bid Window 5.

For future renewable generation bid windows to be successful and bring online the required GWs of generation they will need to steer project developers towards available connection capacity locations (predominantly in the north east).

iii Total solar and wind project interest is scaled to the total required solar and wind additions in the assessed scenarios.

A systematic alignment between generation and transmission is needed to realise generation capacity additions in the coming 4-5 years. The build out of the required infrastructure to the most favourable renewable generation locations will not solve short-term connection needs. The only way to add ~4-5 GW of new generation per year to the power system in the next 4-5 years is a targeted approach to add as much generation capacity as possible in areas with existing grid capacity. To do this, there are two broad categories of action (see figure 7):

2.A FOCUS NEW RENEWABLE GENERATION CAPACITY IN LOCATIONS WITH AVAILABLE CAPACITY

Action is required to make sure that renewable generation projects are developed at those locations where transmission capacity is available. Additionally, the build out of renewables at decommissioning coal plant sites further takes advantage of the existing grid and should be supported. The acceleration of rooftop solar PV could also be further supported, as there is no additional transmission grid connection required when generation is at the same location as consumption.

2.B MAXIMISE THE AMOUNT OF GENERATION CAPACITY CONNECTED AT ANY SPECIFIC LOCATION

Peak renewable generation only happens during limited hours of the day. To maximise the amount of power generation added on an available grid connection, certain actions can be incentivised: co-locating wind and solar, oversizing generation relative to the grid connection, adding batteries and voluntary curtailment.

Actions		Explanation
2.A **Focus new renewable projects in areas with available grid connection capacity**	2.A.1 **Limit near term renewable development to areas with transmission capacity**	• Use ~17GW of capacity that can be unlocked in the short term to build new renewable projects. • Estimated 10-15% higher cost of generation still lower than new coal generation.
	2.A.2 **Build renewables projects at/near sites of decommissioned coal plants**	• Use ~10GW of capacity that becomes available through planned decommissioning of existing coal generation plants. • Further research needed to identify coals plant locations with best resources for renewables.
	2.A.3 **Accelerate uptake of rooftop solar**	• Use rooftop space on residential and commercial buildings to create additional generation capacity, potentially up to 7.5GW in 2035. • Feed-in tariffs and financing solutions for high upfront investments needed to accelerate uptake.
2.B **Maximise the amount of generation capacity connected at any specific location**	2.B.1 **Co-locate solar and wind**	• Develop solar & wind at the same location to increase the amount of generation capacity that can be connected. • Due to the different generation profiles between solar and wind, more power can be fed into the grid in total.
	2.B.2 **Oversize capacity of renewables**	• Increase the installed renewables capacity relative to the size of the grid connections. • Although at peak generation some electricity will be lost (e.g. 4% when oversizing solar by 20%), in total more power will be fed into the grid.
	2.B.3 **Use batteries to shift renewable generation in time**	• Store electricity at moments of peak generation to feed back into the grid at times of lower generation. • Batteries require significant investments that would need to be incentivised.
	2.B.4 **Include voluntary curtailment**	• Allow the system operator to curtail renewable generation during limited periods of high usage of transmission infrastructure, in this way additional capacity can be connected on otherwise unavailable grid capacity. • Viability of the business case will decrease and needs further research.

Figure 7: Actions to optimise the use of available transmission capacity

2.A

FOCUS NEW RENEWABLE GENERATION CAPACITY IN LOCATIONS WITH AVAILABLE CAPACITY

A systematic approach is needed to make sure generation capacity is connected in areas with available grid connection capacity in the coming 4-5 years. Below we describe three actions that should be taken to this end: (1) limit near term renewable development to areas with transmission capacity, (2) build renewables projects at sites of decommissioned coal plants, (3) accelerate uptake of rooftop solar PV.

2.A.1

Limit near term renewable development to areas with transmission capacity

When renewables developers are evaluated only on price, with no parameters on location of projects, they will prioritise developing projects in areas with the best solar/wind resource. Currently most interest for building renewables is in the south west, where current grid connection capacity is highly limited. There is thus a need to direct developers to areas with available grid connection capacity. Better insight for renewable developers into where grid connection capacity is available can boost developments in the right locations. To this end, Eskom published the Grid Connection Capacity Assessment prior to Bid Window 6. In Bid Window 6, there was a significant increase of bids in Free State, which had capacity but slightly less attractive solar and wind resources. However, capacity was taken up in the meantime by embedded generation that is secured through private Power Purchase Agreements (PPAs). In the end, the grid connection capacity that renewable bidders in the bid window anticipated to be available, turned out to not be available.

In practice, building in areas with grid existing capacity means developing renewable generation in areas that do not have the most optimal solar and wind conditions. Many of these areas still have strong solar and wind resources. For example, the solar capacity factor[iv] in the least favourable solar region of South Africa is still higher than the solar capacity factors in the best regions of Spain, and twice as high as in the Netherlands, the country with the second most solar panels per capita.

Generation electricity in slightly less favourable areas could lead to a 10-15% higher cost of electricity generation[v]. Our estimate is that the solar PV Levelised Cost of Electricity (LCOE) in the locations with grid capacity would be 10-15% higher than the LCOE in the locations with best solar resources[vi]. The cost of electricity from solar in these 'slightly less favourable' locations is still significantly lower than the cost of electricity from new coal power plants[vii]. The point being, adding new generation capacity through solar farms in locations with available grid connection will still bring down the cost of electricity. Connecting to already available grid capacity also reduces required investments in transmission, which reduces overall cost of electricity for consumers and businesses.

iv The capacity factor shows how much energy can be produced on average as a percentage of the total energy producing capacity of the power plant / generation unit

v The Levelised Cost of Electricity is equal to the average net present cost of electricity generation for power generation plant over its lifetime and is a metric to compare cost of electricity generation across sources and locations.

vi Based on indicative calculations by the Blended Finance Taskforce, comparing the LCOE of a PV plant in the region with the best solar resources (Northern Cape), compared to the LCOE of a PV plant in the region in the north east with the best solar resources (Free State and North West) and the LCOE of a PV plant in the region with the most grid capacity (Mpumalanga).

vii Based on LCOEs of 46-56 $/MWh for solar, and 81-91 $/MWh for coal in 2020 in South Africa (CSIR, BloombergNEF)

2.A.2

Build renewables projects at/ near sites of decommissioned coal plants

Grid capacity that is freed when coal plants are decommissioned, can be re-utilised to connect renewables. Eskom has already started working on this solution by signing land leases for 2 GW with independent renewable power producers at the Majuba and Tutuka power stations[16]. With this approach, existing infrastructure and equipment can be re-utilised, and jobs created in a location where many will be lost as the coal plant retires. Approximately 10 GW more coal generation capacity will be decommissioned over the next ten years. Some of this could be unlocked for renewable generation. Further research is needed into which locations might be most suitable and what (investment) needed to connect renewable generation.

The main consideration of this action is that all coal power plants are located in the north east where renewables resources are less favourable compared to the south west. As above this may translate to ~15% higher LCOE in the north east relative to the south west. However, there are system savings in using existing grid connections. On balance this could be a cost and resource efficient approach.

Further research is needed to understand how much of the 10 GW grid capacity could realistically be used by new build renewables and when. A helpful study would be to investigate and rank the attractiveness of coal plant sites for new renewables developments and overlay this with coal plant decommissioning timelines. The study would need to account for many considerations: quality of solar/wind resource, land availability, site remediation requirements, and more.

2.A.3
Accelerate uptake of rooftop solar PV

The use of rooftop solar alleviates transmission grid constraints. Rooftop solar has taken off in many places across the world. A good example of this is Viet Nam where more than 7 GW of rooftop solar capacity was installed in 2020[17]. Solar provides a source of electricity generation close to where the demand is, alleviating constraints on the transmission grid as less electricity has to be transported through the grid. While South Africa has strong solar resources throughout, uptake of rooftop solar has been relatively slow. Reasons for this are high investment cost, lack of government support mechanisms and limited financing options[18]. Solar on rooftops can be established in residential areas and on commercial and industrial buildings like warehouses. Estimates are that the total market for rooftop solar could reach 7.5 GW of installed capacity in 2035[19].

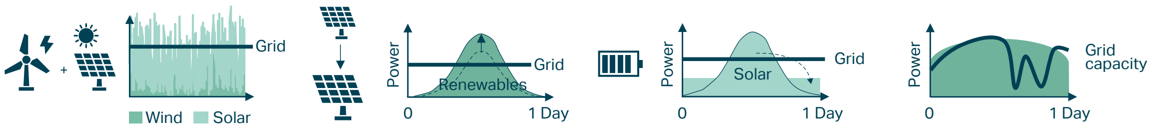
Establishing more rooftop solar requires investments and regulation. Costs of solar panels have come down significantly in the last decade, however the upfront investment can still be high for individuals and even businesses. Attractive business models are emerging through which solar panels are financed by the installer or a third party financing partner, and then paid off over a certain amount of time. The business case for this investment can be strengthened when individuals / businesses are paid for feeding electricity back into the local grid (known as 'net metering'), when it is not being used by them. Such an arrangement has already been announced by the South African government[20]. Small-scale embedded generation (SSEG) like rooftop solar on homes and commercial buildings also comes with challenges to the grid. The integration of high amounts of solar on the grid leads to a phenomenon called the "duck-curve" problem. It refers to the issue that solar production is high during the day when the sun is shining but very low during the night. Power storage can alleviate this problem, but is inefficient at the induvial level due to its high cost. This means that the addition of SSEG will need system level coordination and regulation. This holds both on a local level with respect to the capacity of the distribution grid and on a system level with respect to energy storage and the stability of the grid. This will all require further efforts and research.

2.B
MAXIMISE THE AMOUNT OF GENERATION CAPACITY CONNECTED AT ANY SPECIFIC LOCATION

A renewable-based power system requires a different way of thinking about size of the grid connection for generation capacity. A transmission grid is meant to transport electricity from locations of generation to demand. Traditionally, transmission infrastructure has therefore been designed to be able to transport the peak power generation of a power plant. For renewables, this peak may only occur during several hours in the year. This means it typically does not make sense to build grid connections for the peak generation of renewables. When the installed capacity of a renewable power plant is larger than its grid capacity, the generated power is higher than the grid capacity during some moments of the day and year. In these cases, some power cannot feed into the grid and has to be ‘curtailed’.

Given the constraints on the transmission grid, it makes sense to adjust renewable generation capacity such that it provides a more consistent flow of electricity throughout the day and year, making full use of the available transmission capacity. Below we discuss four actions to optimise the use of grid locations at specific locations: (1) co-locate solar and wind, (2) oversize capacity of solar farms, (3) add batteries to smooth power supply, and (4) include voluntary curtailment. See figure 8.

	2.B.1 **Co-locate solar and wind**	2.B.2 **Oversize capacity of renewables**	2.B.3 **Use batteries to shift renew-able generation in time**	2.B.4 **Include voluntary curtailment**
Explanation	• Co-located solar and wind farm sharing one grid connection. • More solar and wind connected to same amount of grid capacity.	• Oversizing renewable project compared to its grid connection. • More capacity can be installed on the same amount of grid capacity.	• Battery storage to reduce generation peak renewables by storing electricity. • More renewables can be installed on the same amount of grid capacity.	• Project commits to voluntary curtail if full grid connection is temporarily unavailable. • Allows for connecting capacity in places that might otherwise be unavailable.



	2.B.1	2.B.2	2.B.3	2.B.4
Economics Upside	• Grid costs can be shared between solar and wind. • Higher and more consistent supply of electricity.	• Higher and more consistent supply of electricity.	• Ability to deliver more electricity in hours with high electricity demand.	• Ability to connect capacity and deliver additional power into the grid in currently constraint areas.
Cost	• Curtailment (depending on configuration). • Either solar or wind might not be in most optimal location.	• Additional curtailment, e.g. for solar ~1-10% of all electricity generated in a year depending on oversize ratio.	• A battery with a sufficient energy capacity is needed to effectively reduce the power peak of renewables.	• Grid connection capacity will be variable and therefore introduces higher amount of revenue uncertainty.

Figure 8: Actions to maximise the amount of generation capacity connected at any specific location [viii]

viii As an example, when co-locating a 75 MW solar and 100 MW wind farm on one grid connection of 100 MW in Kleinzee, ~3% of the plant’s production would potentially be curtailed

2.B.1
Co-locate solar and wind

One way to optimise the use of an existing grid connection is to not only build solar or wind at a given location, but an optimised combination of the two. These 'solar-wind hybrids' can reduce the variability of total power output from the location, which allows more of the grid's transmission capacity to be utilised over time. Since solar and wind farms often do not produce electricity at the same moment in time, they can be complementary power sources on the same connection.

A potential economic upside for solar-wind hybrids is that both technologies can share grid connection costs, which usually makes up a significant part of project costs. However, there will be moments that both the solar and wind farm produce more electricity than can be fed through the grid connection. During these moments electricity is lost. The resulting business case needs to be evaluated on a location-by-location basis.

In order to promote hybrid power plants, a specific category could be introduced into the renewable procurement (REIPPP) programme. It is not always physically possible to locate solar and wind farms in the same place, but it is worth to investigate options to do so where possible. As an example, the Risk Mitigated IPP Procurement programme was made technology agnostic and was successful in procuring a solar-wind hybrid project[21].

2.B.2
Oversize capacity of renewables

Oversizing renewables gives a more stable supply of electricity feeding into the grid. Especially solar, but also wind farms, are a very clear example of a power source that does not often reach its maximum power output. Renewables developers anticipate this already by oversizing generating capacity relative to their grid connection. When renewables are even further oversized, more generation capacity can be installed on the same amount of grid capacity. On average more electricity can then be fed onto the grid. Additionally, the overall need for adding storage capacity decreases when renewable capacity is oversized.

On a system's level, oversizing renewables reduces the need for energy storage capacity. Renewables oversizing both decreases the need for batteries and allows for selling additional electricity. There is a limit to oversizing, as at a certain point additional cost of oversizing will not outweigh the incremental decrease in battery requirements and incremental additional revenues. The overall relationship can be seen as a U-curve where oversizing reduces overall cost initially, but increases cost after a certain inflection point when oversizing too much.

Although additional oversizing can be optimal from a system's perspective, it is likely not from an individual producer perspective. Oversizing comes at the cost of power not being fed into the grid, or 'curtailed', during some times of the day. Further oversizing thus creates more curtailment. Developers will therefore not likely voluntarily oversize their plants more than their estimated economic optimum. For the entire electricity system however, further oversizing can be economically optimal since the amount of curtailment could be limited. We estimate curtailment for solar to be ~1% with 10% oversizing and 4% with 20% oversizing. Further research is needed to confirm this and determine a reasonable oversizing ratio while maintaining a viable solar business case. To stimulate oversizing, a larger overbuilding ratio for renewables could be set as a prerequisite to bid in the REIPPP programme to incentivise more efficient use of available grid capacity.

viii As an example, for a solar farm in Kleinzee (relatively high solar and wind resources), for the year 2019, when oversizing 10%, ~1% of curtailment is expected. When oversizing 20%, ~4% of curtailment is expected. When oversizing by 30%, ~10% of curtailment is expected. Further analysis is required to come to optimal ratios

2.B.3
Use batteries to shift renewable generation in time

Adding batteries helps to create a more consistent power supply by shifting generation in time. Batteries can store electricity at moments of peak generation, when electricity would otherwise be curtailed, and discharge that electricity into the grid at moments when limited power is being generated by solar/wind. Renewable generation can be sized larger than their associated grid connection by adding batteries that ensure produced renewable electricity is captured at moments of high electricity generation and fed onto the grid later.

While batteries bring additional cost, they also generate more revenues. When more renewable capacity can be connected to the same grid connection size, batteries can increase revenues by helping deliver more power to the grid through a constrained grid connection. However, adding batteries does come with significant investment. Batteries could be stimulated via the REIPPP by including battery use in the renewable generation tenders or by requiring that projects use a certain minimum average % of their grid connection throughout the year.

2.B.4
Introduce voluntary curtailment

Voluntary curtailment could be attractive if the full transmission grid capacity on a certain segment is not always guaranteed to be available. In Eskom's current Generation Capacity Assessment (GCCA), transmission infrastructure is rated unavailable if there is a risk that new generation capacity would not be able to feed electricity into the grid at all times at the quoted capacity. Theoretically, there could be cases where infrastructure is only congested during certain, limited moments of the day or week. In these cases, grid capacity could actually be available if a renewable developer where to voluntary and upfront agree to curtail if instructed to do so by the system operator at moments where the transmission infrastructure is congested. This voluntary curtailment commitment could theoretically unlock additional capacity without or with limited, targeted investment.

Further research is needed with respect to technical feasibility and viability of the business case for voluntary curtailment. From a technical perspective, voluntary curtailment is only possible if the system operator can be sure that a producer does follow up on its promise and actually disconnects when instructed to do so. From a financial perspective, voluntary curtailment introduces additional revenue risk on the side of a renewable generation developer. The viability of the business case will likely depend on how much curtailment is expected to take place and how big the (un)certainty around this is. If curtailment is only expected for a limited amount of hours per week or month, the business case may still be viable.

03

INCREASING THE NEW TRANSMISSION INFRASTRUCTURE BUILD RATE

A shortage of 36 GW transmission grid connection capacity may remain between 2023 and the early 2030s. Even if the 17 GW of transmission grid capacity that can be unlocked is fully used, 36 GW additional generation capacity needs to be connected. This means there is currently insufficient transmission capacity for over 60% of the generation capacity that needs to be connected before early 2030s.

The gap can be reduced through the additional actions discussed in chapter 2, but a substantial gap will likely remain. Especially when accounting for the fact that even more (renewable) generation will be needed after the early 2030s. It is therefore crucial that accelerating the build rate of new transmission lines starts now.

3.1 THE CHALLENGE FOR SCALING THE TRANSMISSION BUILD RATE

Based on Eskom's Transmission Development Plan (TPD) 2023-2032, about 14,000 km of lines needs to be constructed in the next ten years. As shown in Figure 9, this requires an increase in build rate to on average ~2300 km per year in 2028-2032. Achieving this 8 times increase relative to the present build rate requires significant efforts as planning, permitting, procurement and financing capabilities need to be scaled substantially.

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

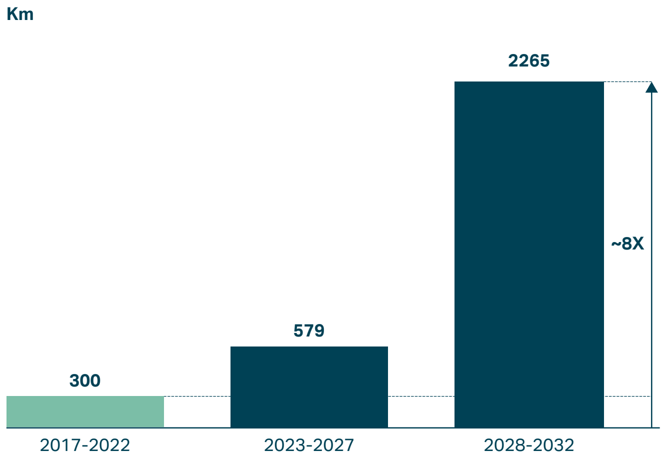


Figure 9: Required transmission line build rates 2023-2032, based on Eskom's TDP

Increasing the grid build rate is not only relevant for the coming decade, but also essential to enable further increases in generation capacity after 2030. Even if 53 GW of generation capacity is added until the early 2030s, there is still a lot to be done ahead of 2050 to fully transition the power system. Until 2050, another 85 GW of generation capacity[ix] may have to be built and connected to meet a growing energy demand, achieve energy security and the meet energy transition goals. To connect this generation capacity, more transmission capacity will be needed.

In the coming 10-12 years, investments of 235-372 bn ZAR ($14-22 bn[x]) are needed to fund the transmission build out. Eskom's Transmission Development Plan estimates that 48 bn ZAR is needed to construct ~3,000 km of lines and 27 GVA of transformer capacity between 2023 and 2027. Scaling that figure according to the cost per kilometre of line, 235 bn ZAR would be needed for ~53 GW. This estimate may still be on the lower end as the Just Energy Transition Investment Plan (JET IP) estimates a transmission investment need of 372 bn ZAR for 2023-2035[22].

ix Following a scenario modelled by Meridian Economics (Vital Ambition paper): moderate renewable pathway (85 GW).
x The following conversion factor has been applied: 1 ZAR = 0.058$

3.2
NATIONAL STRATEGIC PROGRAMME TO OVERCOME EXISTING BARRIERS

A national strategic programme of investment is urgently needed for addressing barriers to accelerate the grid build out, to avoid continuation of load shedding into the late 2020s. Without an accelerated grid build out, the country will continue to suffer from lack of energy security for years if not decades to come. The national strategic programme of investment can build on South Africa's unprecedented leadership to finance a just energy transition. Existing plans such as the Just Energy Transition Investment Plan, Eskom's Transmission Development Plan, the forthcoming Integrated Resource Plan and the updated Energy Development Plan provide a great starting point. The transmission grid programme needs a strong delivery mindset, working from a clear and coherent programmatic approach and needs to be empowered to tackle key barriers (as discussed in this chapter). Tackling the key barriers to rapid grid build out requires active involvement of key decision-makers. Different government bodies need to work together in a coordinated way to tackle financing, procurement and land permit barriers. Coordination with private renewable generation companies will be needed to develop transmission capacity and generation in sync.

Case examples from other countries show that a national strategic approach can help. Many countries face similar transmission challenges to South Africa's. Often favourable renewable electricity generation locations are different from conventional power stations (for example in Chile and Brazil) and the required large-scale transmission build outs face significant barriers. For example, in the Netherlands, the shortage of technical personnel for building transmission and distribution grids is an important limiting factor for advancing the power system. While different countries are choosing different mechanisms, most are introducing some form of enhanced coordination in the face of these large-scale transmission build out challenges. Chile has established an independent National Electric Coordinator that oversees the transmission grid and system planning process, identifying required grid extensions[23]. The Netherlands has established national and regional energy strategies, which has created a dialogue between different stakeholders to identify renewable locations, and to assess where grid capacity is and should be available[24]. In Australia, a coordinated effort, 'Rewiring the Nation', to solve transmission issues was launched[25].

A national strategic transmission programme can drive low-carbon economic growth and job generation. The scale of the transmission line building programme requires scaling up capacity of contractors to build transmission lines, who will be needed for decades to come. Some training and reskilling of workers is needed to build sufficient capacity within the workforce to handle this demand. Besides the direct job creation effects, a significant grid build out enables job creation in low-carbon economic sectors. This holds especially for those sectors that will benefit from electricity supply that is low-cost, reliable and low-carbon, which is critical for export industries.

The transmission build programme can attain an 8 times increase in transmission infrastructure build out by addressing four key barriers. These barriers are summarised below and in figure 10. They are described more extensively in the following paragraphs.

1

Access to sufficient capital

Eskom faces a significant debt-burden which results in difficulty to attract sufficient capital to finance a scale-up in grid build out.

2

Planning & permitting hurdles

Building out transmission infrastructure requires land rights (right of way) and permits, which take significant time to acquire and slow down transmission build out.

3

Procurement of materials

The current procurement system is not set up for acquiring the amount of materials needed for rapid transmission grid expansion, such as copper and transformers. National procurement laws that require local sourcing limit the ability to scale.

4

Qualified workforce availability

South African contractors that can execute transmission line build programs are currently not set up for the scale and speed of the build out programme and need additional qualified personnel and equipment.

Barriers to overcome	Explanation	Way forward
3.2.1 **Access to sufficient financing**	• Eskom has been facing a **significant debt-burden of 392 bn ZAR of debt** and difficulty to attract capital for **~235-372 bn ZAR required transmission investments** until 2035. • **Transmission unbundling in separate Transmission Company** meant to free more investment capacity in transmission grid – but constraints likely remain.	• Explore options for transmission **financing outside off transmission authority balance sheet.** *See next chapter for a more detailed discussion*
3.2.2 **Planning & permission hurdles**	• The timelines for development of transmission lines are primarily dictated by the timelines of **(environmental) permits and obtaining right of way,** which may involve 420-840 km2 of land until early 2030s. • Timelines from to design to completion need to be **reduced from current minimum of 7-10 years.**	• Assign the transmission build out a Strategic **Investment Project (SIP) status** • **Use prioritised zones** where development of lines is accelerated
3.2.3 **Planning & permission hurdles**	• Increasing the speed of transmission line build-out requires a **significant scale up in the procurement capacity** to procure all materials needed for the build-out, such as copper, steel and transformers. • The **low transmission build rate in recent years** and national **procurement laws that require local sourcing limit** ability to quickly scale purchasing of essential products, especially things like transformers that are hard to purchase from within South Africa.	• Allow Eskom and/or the NTCSA to draft its **own procurement policy** that allows for fair, equitable, transparent, competitive and cost-effective procurement • **Allow for long-term procurement** contracts to order materials and products in advance
3.2.4 **Qualified workforce availability**	• South Africa contractors that can execute transmission line build programs are **currently not set-up for the scale and speed of the build out program** (from ~300km to 2,300 km per year) and will need additional qualified personnel and equipment.	• **Create a more predictable environment** that gives contractors incentives to invest • Invest in **workforce training programs** to ensure sufficient qualified, local employees

Figure 10: Four key barriers to overcome in accelerating the transmission build out

3.2.1
Access to sufficient capital

Eskom has a significant existing debt-burden, with 392 bn ZAR of debt[26]. At present Eskom is responsible for financing and building the transmission grid. These responsibilities are to be transferred into a separate transmission company, wholly owned by Eskom. Gross financing cost currently is Eskom's second largest cost category, amounting to ~20 bn ZAR per year, representing ~15% of revenues. Since the tariffs charged for electricity transmission are inadequate to cover Eskom's cost, continued government support is required. This financial position makes it difficult to make sufficient investments in both maintaining and building generation capacity and the transmission and distribution grids. In recent years this had led to underinvestment, especially in transmission.

The government has been seeking solutions to solve the debt problem and has announced to take over ~130 – 260 bn of Eskom debt[27]. Simultaneously, an unbundling process is ongoing in which the power transmission department is placed in a wholly owned subsidiary of Eskom, the National Transmission Company of South Africa (NTCSA). The creation of the NTCSA is meant to free more investment capacity and create more focus on transmission grid investments. However, it is likely that difficulties remain with regards to obtaining sufficient funding for new transmission grid infrastructure. The size of the required capital in this decade only could be higher than the debt-take over and that still excludes other required investments in maintenance and new generation capacity that Eskom may pursue.

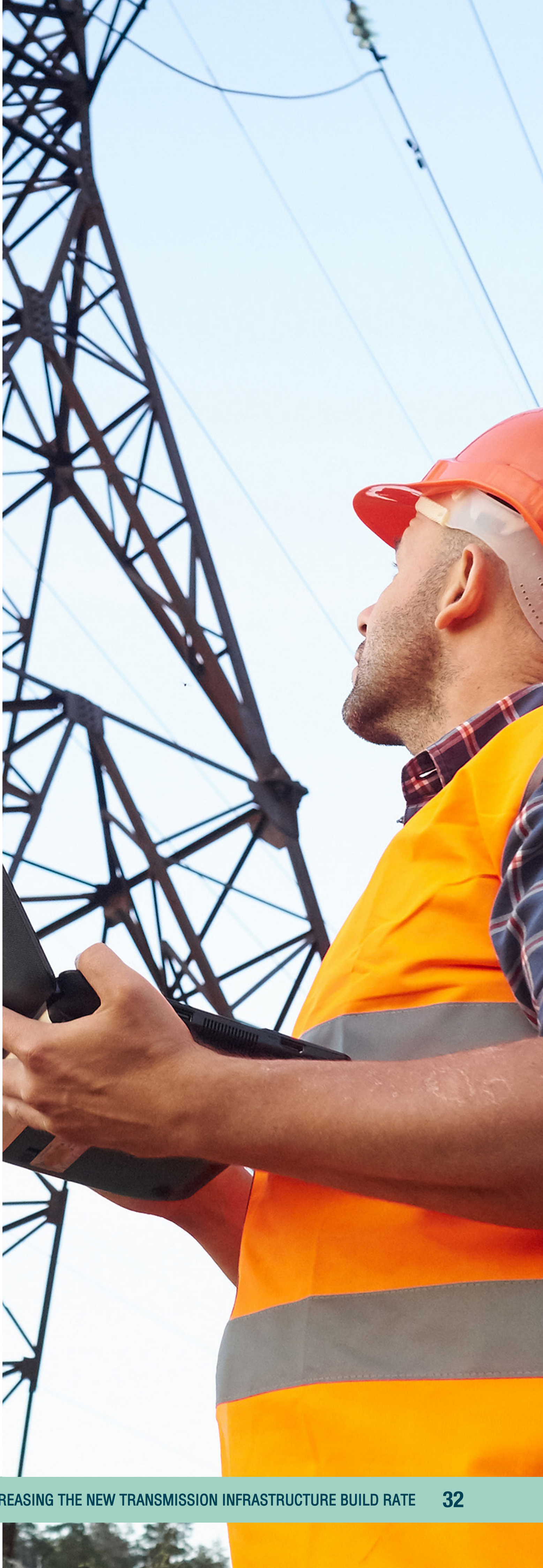
In the announced set-up, the NTCSA will only be able to attract capital via Eskom treasury through intercompany loans. The intercompany loan of Eskom to NTCSA has been sized based on historic transmission funding needs, which are significantly below the future transmission investment needs. The unbundling of Eskom's transmission department also does not change the underlying revenue collection problems that are important for securing sufficient capital.

It is crucial to solve the financing hurdle to secure access to capital. Realising stronger reliability of revenue streams is an important action. This includes addressing the potential financial risk of large customers starting to disconnect from the main grid and organising their own power supply off-grid. Currently, large customers make up a significant share of the total electricity demand and revenues. An additional lever is to use alternative finance models. There are models that could be used to finance transmission infrastructure off the transmission company balance sheet, while maintaining the desired degree of control. In the chapter 4 we provide more insight in the potential for the use of these models.

3.2.2
Planning & permitting hurdles

The timelines for development of transmission lines are primarily dictated by the timelines of obtaining land rights and permits. It currently takes at least 7-10 years to complete major transmission projects, largely due to complexities in obtaining right of way for the long distances associated with transmission lines. It can especially be complex to establish right of way for long transmission line projects that are needed between favourable renewable locations and areas with high power demand. Environmental assessments need to be conducted on intended routes and authorization and registration processes need to be performed. Right of way requirements may involve 420-840 km^2 of land until early 2030s[xi]. It is essential to reduce planning and permitting hurdles to facilitate an increase of the transmission grid build out rate.

In order to accelerate planning and permitting times, transmission line building could be regarded as a Strategic Investment Project (SIP). Initiatives have already been started to prioritise land use authorisation for energy projects, reduce registration process time and to process servitudes quicker. For other Strategic Investment Projects (SIPs), processes related to authorization and permitting are sped up by running them concurrently instead of sequentially[28]. Priority zones for transmission line development (Renewable Energy Development Zones) have been identified and can be used to speed up planning and permitting processes.



xi Assuming 14,000 km of new lines and 30-60 meters of width for transmission lines.

3.2.3
Procurement of materials

Increasing the speed of transmission line build-out by 8 times requires a significant scale up in the procurement capacity. Both an increased amount of base materials such as copper and steel, and products like transformers and line building machinery, are needed. The required products and suppliers are not necessarily readily available in South Africa. Existing procurement laws that are limiting the abilities to procure from foreign suppliers make it more challenging to acquire the products needed for the transmission build out. The slower transmission infrastructure build rate and unpredictability in recent years created insufficient incentives for local supplier to invest and scale their business to meet increasing demand for building infrastructure.

To scale procurement capacity for the transmission build out, action is needed. Eskom and/or the NTCSA could be allowed to draft its own procurement policy that allows for fair, equitable, transparent, competitive and cost-effective procurement (following the constitution)[29]. First steps have been taken. The relaxation of local procurement requirements has been announced and the National Treasury has provided Eskom exemptions from local content designations provided for transformers and insulators[30]. Additionally, orders of items such as transformers could be performed in bulk, in order to obtain economies of scale and to reserve certain production capacity.

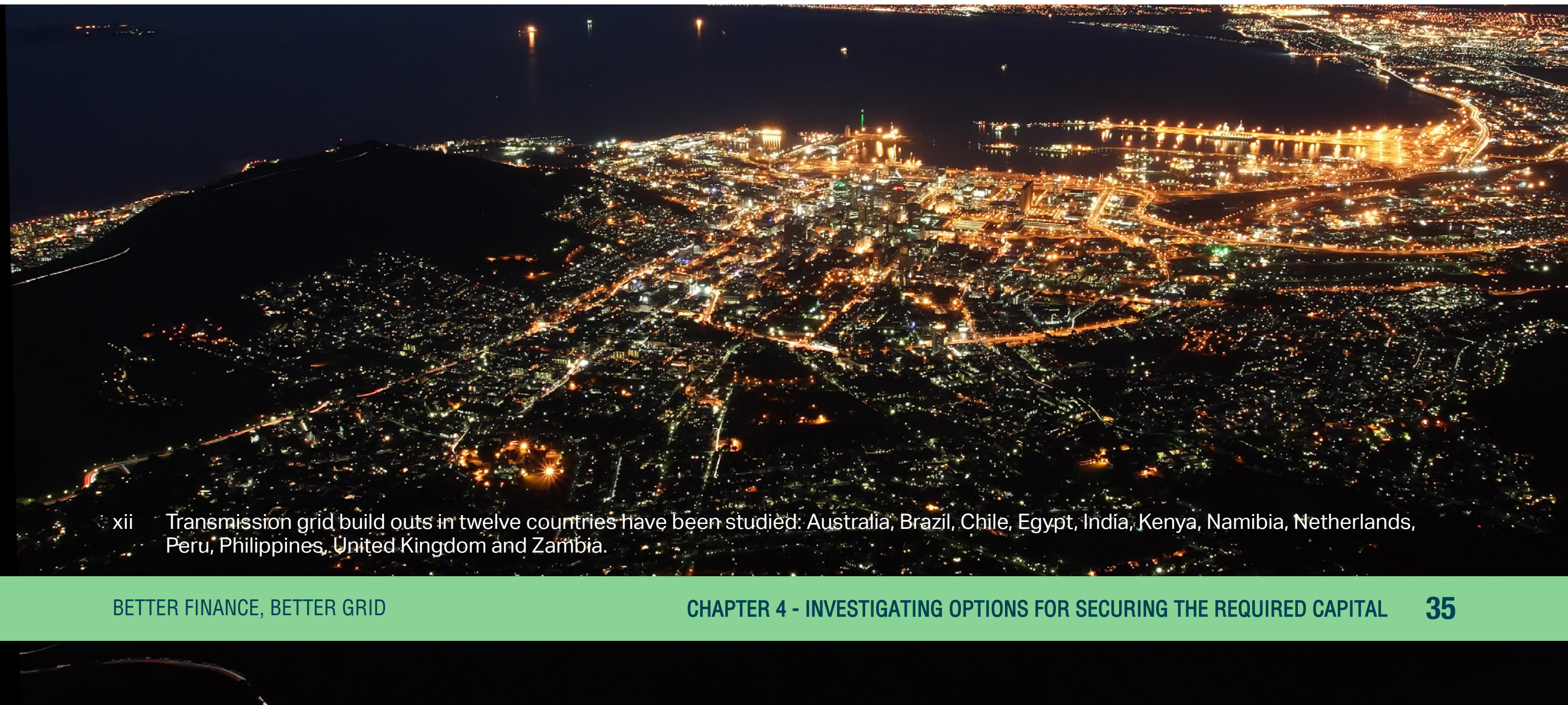
3.2.4
Contractors & qualified workforce availability

When increasing the build out rate of transmission infrastructure, additional qualified personnel is needed. Existing contractors do not have the workforce and machinery available to increase the speed of build out of transmission lines from ~300 to ~2,300 km per year. Machinery needed in construction, such as cranes, off-road vehicles and large trucks, has to be ordered. Workforce availability for managing the build out is limited due to a lack of resource capacity in Engineering, Procurement and Construction Management.

To increase the qualified workforce availability, investments in workforce training programs are needed. These could either be state-led or private sector-led. An integral programme may be used to align the available education and the workforce requirements for the energy transition. Additionally, more certainty and clearer commitments on volumes would enable contractors to make required investments in machinery and hire new employees.

04 INVESTIGATING OPTIONS FOR SECURING THE REQUIRED CAPITAL

As explained in chapter 3, the current financial situation of Eskom, and likely the new transmission company, places limits on its access to capital. This chapter further explores options for unlocking barriers to accessing the required capital. With a focus on models that allow for transmission financing outside off Eskom's and the transmission company's balance sheet. Throughout the chapter we draw on a range of selected case studies to give insight into how other countries have been dealing with large transmission build outs, typically driven by renewable additions to the system[xii].



xii Transmission grid build outs in twelve countries have been studied: Australia, Brazil, Chile, Egypt, India, Kenya, Namibia, Netherlands, Peru, Philippines, United Kingdom and Zambia.

4.1
EXPLORING THE DIFFERENT FINANCING MODELS

While several purely public financed transmission utilities exist, many well capitalised utilities use off-balance sheet structures as well. Transmission infrastructure projects can be fully financed on the balance sheet of the transmission company, often including government loans and/or equity. This is Eskom's current model. Internationally, the Netherlands are a good example of this operating model. The transmission utility is able to borrow against its own balance sheet with the Dutch state as 100% shareholder. However, not all financially solid transmission utilities finance their investment fully through their own balance sheet. Other models are used to decrease the capital burden for the transmission utility or in situations where this is expected to lead to lower overall cost. In India, the majority of transmission investment is by government-owned businesses.[31] However, since the introduction of alterative models, the share of transmission investment outside of the central and state government-owned utilities increased to about 8% in 2019[32].

The balance sheet of the transmission utility can carry the full capital requirements for the transmission infrastructure, or this capital can be raised off its balance sheet or a mix of both. Figure 11 summarises the range of different models[33]. Given the need to increase the access to capital for transmission investment, the focus below is on models that go beyond the current financing structure. Four types of models for financing transmission infrastructure outside off the transmission company or government balance sheet are:

Full privatisation

The full ownership and operation of the network is transferred to a private party for an indefinite period of time.

Whole of network concessions

A private party is granted the right to develop, build, operate and maintain a country's transmission infrastructure (or portion thereof) for a defined period of time, after which the transmission utility regains control or initiates a new concession.

Independent Transmission Projects (ITPs)

Specific transmission lines are financed and built by private parties under long-term contracts. Different owning and operating structures are possible.

Specific purpose lines

Generation-linked, industry-driven, interconnectors and merchant lines. Generation-linked lines are directly related to generation building projects. Industry-driven lines are specifically build for industry clusters. Interconnectors enable power flow to and from neighbouring country grids (e.g., Namibia) such that each country can benefit from the other when there is excess or lower cost power. Merchant lines are fully private lines (not open access) that connect an area that has previously been isolated from the grid.

Funding structures

Fully public

		Description	Capital Resources	Case Examples
Corporate finance relying on the strength of the balance-sheet	**Government borrowing**	State borrows on its own balance sheet and finances transmission projects	Treasury bonds, MDBs, ECAs	*Egypt*
	State-owned utility borrowing	Utility borrows on its own balance sheet and finances transmission projects	Corporate bonds, ECAs, selected DFIs	*Namibia* *Egypt* *The Netherlands*
Project finance relying on the viability of cash flows from transmission fees	**SPV owned by public utility**	Utility designs an SPV to run a specific transmis-sion line project	Utility equity, DFIs, commercial lenders, sovereign support	

Involving private sector balance sheets

		Description	Capital Resources	Case Examples
Corporate finance relying on the strength of the balance-sheet	**Whole of network concession**	Granting a private party the right to develop, build, operate and maintain a (part of a) country's transmission infrastructure	Transmission customer payments, DFIs,MDBs, corporate bonds, commercial lenders, sovereign support	*Phillipines*
	Full privatization	The full transfer of ownership of (part of) the transmission infrastructure to a private party – government regulation applies	Equity, corporate bonds, commercial lenders, sovereign support	*Chile* *UK* *Australia*
Project finance relying on the viability of cash flows from transmission fees	**Independent transmission project (ITP)**	Transmission line(s) connected with the country network, under long-term contract with a private party. Different build-own-operate – transfer structures possible (BOOT, BOO, BOT))	MDBs, bilateral DFIs and ECAs, commercial lenders, sovereign support	*Brazil* *India* *Peru* *Chile* *Kenya*
	Specific purpose lines			
	Generation linked	Transmission line built by an IPP as part of a generation project, transferred to the utility upon completion	MDBs, bilateral DFIs and ECAs, commercial lenders	*South Africa*
	Merchant lines	Fully private line connecting an area that has previously been isolated – access at full discretion of owner	Equity, corporate bonds, commercial lenders	*Australia*
	Industry demand-driven models	Line(s) specifically financed, built and operated for an industrial area, public & private ownership possible	Industrial players, commercial lenders, project company	*Zambia*

Figure 11: Types of financing mechanisms for transmission grids across the world.[xiii]

These four categories of transmission finance differ with respect to the scope of private responsibility, the assignment of ownership, the need for regulatory reform, and the distribution of risk. The differences are summarised in figure 12 and explained on the next page.

xiii Acronyms in exhibit refer to: DFI = Development Finance Institution, MDB = Multilateral Development Bank, ECA = Export Credit Agency

- **ITPs and specific purpose lines have a project scope, whereas others concern a full network in a country or region.** An important distinction between the models is their respective scope. Whereas ITPs and specific purpose lines concern specifically selected projects, whole of network and privatisations shift responsibility for the full transmission network in a certain country or area. The latter thus includes a larger share of responsibilities for the private sector parties.
- **ITPs only need a limited amount of regulatory reform to be implemented.** For Independent Transmission Projects, relatively little significant regulatory reforms are required and case example show that ITPs can be implemented within a relatively short timeframe[34]. Other models require more time to implement.

In the Philippines, it took two unsuccessful auctions and several years to perform a successful auction for the whole-of-network concession[35]. In all cases, investor confidence in regulatory capabilities for the specific financing model to attract capital is needed.

- **ITPs and specific purpose lines allow for customisation of the desired ownership and control of the transmission company.** In the case of an ITP, the transmission utility can obtain ownership over the transmission assets right after construction or after a specific period of time (e.g. 20 or 30 years). This depends on the chosen ITP model.

	General Models			Context-specific Models		
			Options to be considered for South Africa			
	Full privatisation	**Whole-of-grid concession**	**Independent Transmission Project (ITP)**	**Generation-linked**	**Industry demand-driven**	**Merchant Line**
Scope of the model To what scope can the model be applied?	Full network in a country or region		One or multiple lines	Line directly connected to a generation project	Line for specific industrial area	Single major line between two markets
Regulatory requirements What is needed in terms of regulatory changes?	Requires significant regulatory reform to establish the framework for private sector operation of the transmission network		Need some, but limited regulatory reform to create private sector transmission licensing			
Ownership How is the ownership of the assets organised?	Ownerships of assets at private sector for indefinite amount of time	Assets leased or sold to private party with ownership transfer to government/utility at end of concession	Multiple models possible, including ownership transfer after building stage or after 20-30 years	Multiple models possible, including continued private ownership, ownership transfer after building stage or transfer after 20-30 years		Entirely private ownership (including tariff setting)
Control What responsibilities are taken on by the private sector?	Private sector plans, builds and maintains – based on the regulatory framework	Private sector plans, builds and maintains, based on the concession agreement and regulation	Multiple models possible, from building only to planning, building, maintaining and operating			Entirely private ownership (including tariff setting)
Track Record Has the model been proven in emerging economies?	Few examples of successful privatisa-tions in emerging economies in LatAm and Asia	Few examples of concessions on different continents	Substantial amount of examples across Africa, Asia and LatAm	Some examples exist	Some examples exist	Limited examples it requires a mature power market

Figure 12: Characteristics of different financing models

4.2 FINANCING OFF THE TRANSMISSION COMPANY BALANCE SHEET

Independent Transmission Projects (ITPs) are likely the most successful model for off Eskom's balance sheet financing of transmission infrastructure. ITPs have a proven record throughout a range of developed and developing countries including Brazil, India and Peru. They are relatively less disruptive to the existing model as ITPs can be executed on selected projects, in contrast to privatisations and whole of network concessions that involve full systems. Relatively little regulatory reform is needed to implement ITP projects. This means that ITPs could be realised within much shorter timeframes than other models.

Eskom already has experience with this type of regulatory reform because of the REIPPPP. Although power generation projects are not entirely the same, there are similarities in the approach in working with private parties and lessons from these projects could be used to develop the ITP regulatory framework. ITPs allow for varying models of ownership, risk sharing and division of responsibilities and give optionality to cater to local desires and requirements. One example is the ownership of the asset within an ITP. The ownership could be transferred to the transmission company directly after completion, after a certain pre-defined period (20-30 years) or not at all.

There may also be a role for generation-linked models. Second to ITPs, generation-linked models could be relevant. These would involve joint projects for renewable generation capacity and transmission lines, especially in areas where the required transmission line to connect a renewable generation project is of relatively limited length. Longer lines, such as to connect the south west and the north east of the country are probably less suitable given longer development times and higher risks associated. Other context-specific models seem less relevant as new industry demand driven lines do not bring large contributions to solving energy security and merchant lines are more applicable in privatised power markets.

ITPs have shown to be able to deliver building and operating cost reductions. Off-balance sheet financed projects were used for the development and construction of many kilometres of transmission in Brazil (70,000 km), India (21,000 km) and Peru (6,000 km). While the capital costs for these projects are higher than with concessional loans, competitive pressures and a more diverse set of lenders can lower the overall project cost. In Peru, the off-balance sheet projects have been implemented at a fraction of the expected cost, obtaining 36% cost savings through auctioning transmission projects[36]. In India, a 35% cost reduction was achieved through tariff based competitive bidding[37]. In the Philippines, the electricity distribution tariff per kWh of the transmission system was reduced by 40%[38].

ITPs allow for tailoring control and ownership structures to the local context. The transmission company maintains flexibility in choice of financing models for different transmission infrastructure projects. It can decide to auction several as ITPs, while others are financed on their own balance sheet. Within the ITP model, there is flexibility in terms of task division and ownership of the transmission asset (see also Figure 13). Responsibilities can be divided between the transmission company and a developer in different ways. In an early-stage tender, a developer performs tasks such as project design and the Environmental Impact Assessment, whereas in a late-stage tender the transmission company performs such tasks. With late-stage tenders, investors are not exposed to risks related to route selection, right of way acquisition and permitting. For the transmission company, late-stage tender evaluations may be simpler as covering less different elements, while the viability of a certain design has to be tested in an early-stage tender. In India, the UK and in several countries in South America, late-stage tenders have been used, while Peru has been using early-stage tenders.

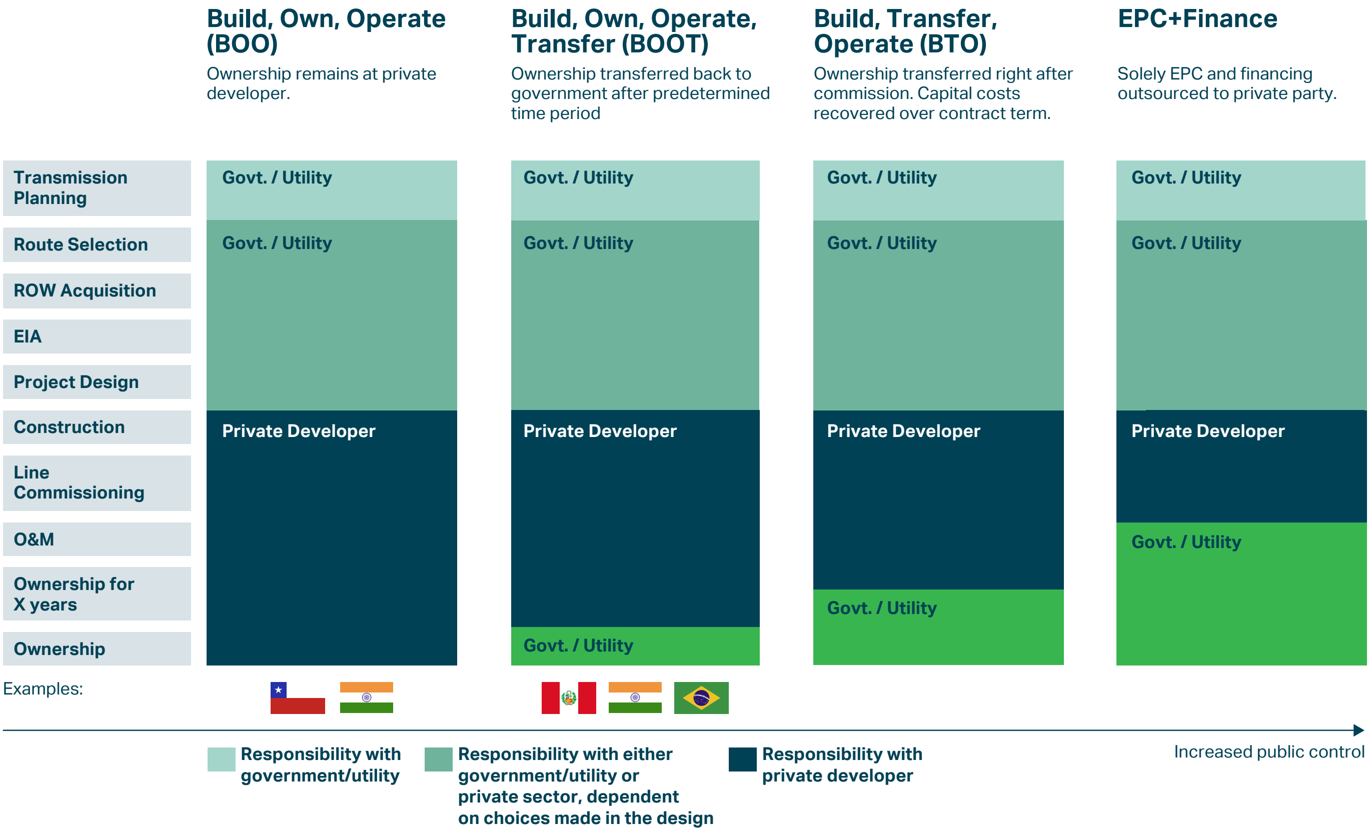


Figure 13: Overview of different types of Independent Transmission Project (ITP) models[xiv]

Independent Transmission Projects (ITPs) do need a clear regulatory framework, strong planning and project selection by the transmission company. Alternative finance models are sometimes perceived to go hand in hand with lower levels of control by the transmission utility. This does not have to be true. ITPs can be designed in many ways through which the desired level of control can be achieved. For example, operational control of the line can be fully with the transmission company. It all depends on the project design and accompanying regulatory framework. A clear and well-designed regulatory framework is a crucial enabler for successful ITPs and can be catered to the local requirements and desires. Project planning capabilities need to be enhanced. The transmission company would be in charge of selecting and designing projects that are suitable for ITPs and auctioning those to the market. Eskom has already gained capabilities on this end through the IPP programmes that can be learned from for ITPs.

xiv ROW = Right of Way, EIA = Environmental Impact Assessment, O&M = Operation and Maintenance, EPC = Engineering, Procurement and Construction

4.3
ESSENTIAL ENABLERS

Effective allocation and mitigation of risks is essential for alternative financing transmission models to work. Figure 14 below maps the main risks in transmission projects across the project stages.

<table>
<tr><th>Risk for Investors</th><th>1 Planning & Preparation</th><th>2 Permitting & Constructing</th><th>3 Operation</th></tr>
<tr><td rowspan="6">Financial</td><td></td><td colspan="2">Demand Risk</td></tr>
<tr><td></td><td></td><td>Termination payment (if applicable)</td></tr>
<tr><td></td><td></td><td>Credit & Revenue collection</td></tr>
<tr><td></td><td></td><td>Inflation</td></tr>
<tr><td></td><td colspan="2">Currency fluctuations</td></tr>
<tr><td></td><td colspan="2">Interest rates</td></tr>
<tr><td>Land</td><td colspan="2">Land acquisition (rights/permits)</td><td></td></tr>
<tr><td rowspan="5">Technical</td><td></td><td>Construction & commissioning</td><td>Daily operations & maintenance</td></tr>
<tr><td colspan="2">Scope changes</td><td>Service level</td></tr>
<tr><td colspan="2">Technology</td><td></td></tr>
<tr><td></td><td colspan="2">Generation-transmission interface</td></tr>
<tr><td></td><td colspan="2">Accidents, damage, theft</td></tr>
<tr><td rowspan="2">Social</td><td></td><td colspan="2">Health and safety</td></tr>
<tr><td></td><td colspan="2">Employment</td></tr>
<tr><td rowspan="3">Environmental</td><td></td><td colspan="2">Climate & Biodiversity</td></tr>
<tr><td></td><td colspan="2">Pollution</td></tr>
<tr><td></td><td colspan="2">Non-political force majeur</td></tr>
<tr><td rowspan="4">Political & Regulatory</td><td colspan="3">Policy & law (including taxes) changes</td></tr>
<tr><td colspan="3">Regulatory changes / delays</td></tr>
<tr><td colspan="3">Political force majeur</td></tr>
<tr><td>Planning delays</td><td>Issuance of licenses & permits</td><td>Renewals, modifications</td></tr>
<tr><td rowspan="2">Disputes</td><td rowspan="2">Information gap for international investors</td><td colspan="2">Contractual disputes</td></tr>
<tr><td colspan="2">Tariff disputes</td></tr>
<tr><td colspan="4">Ideally risks are allocated to the party that is best able to reduce, control and manage it</td></tr>
</table>

Figure 14: Indicative overview of transmission project risks across the project lifecycle

Most risks are common across financing models, but they may be allocated in different ways. As transmission infrastructure involves long-term investments with high capital expenditure, it faces significant risks independent of the chosen financing model. The core risk categories include financial, land, technical, social, environment, political, regulatory and dispute risks. These risks occur in different parts of the project lifecycle, from planning & preparation to permitting & construction and operation. As a general principle, risks should be allocated to the party that is best able to reduce, control and manage those risks. Therefore, risk allocation may differ between full privatisation, concessions, ITPs and other financing structures. In any case, risks need to be carefully understood and addressed.[39]

Two of the most challenging risks include providing a secure revenue stream and acquiring the 'right of way' on the land that is needed to build the transmission lines on. One of the most important risks is the revenue stream for transmission. This holds especially for ITP structures, as these rely on project financing. Another key risk is acquiring the 'right of way' for building transmission lines on the intended route. Building thousands of kilometres of lines means crossing a lot of land. Land is also needed to build substations. Acquiring access rights and ownership is a crucial factor for transmission projects and is a lengthy, costly and unpredictable process. Usually, governments are best placed to manage those risks as they have most control on these processes.

Some form of sovereign support in managing risks is required for ITP funding models. Credit enhancements can be required to reduce revenue risk for investors. These can be provided by the government but also by DFIs and MDBs. Escrow accounts and guarantees are regularly used mechanisms. With escrow accounts, a share of the revenues of the government-owned utility is placed in a secured account that is used to pay out the revenues to investors. In this way the ITP has the first claim on the revenues. When escrow arrangements are not sufficient to make transmission projects investable, government guarantees to back payment obligations to investors can be put in place. These could also be supplemented or replaced by multilateral guarantees. Another risk category that typically requires some public sector support is political and regulatory risk, especially with respect to force majeure and significant regulatory changes that could not be foreseen at the time the contract was established.

Catalytic allocation of public capital can play a crucial role in financing new transmission infrastructure and enabling a pathway to a more secure and equitable power system. Through project finance structures such as ITPs, capital can be unlocked for building, maintaining and/or operating transmission assets. As discussed above, managing revenue risks is a crucial element in these project finance models. Guarantees to ITPs can be an effective way to help mitigate revenue, timing and other investment risks. This helps lower the cost of capital and aids making transmission infrastructure projects investable. A second way through which capital can be used in a catalytic way is to provide concessional loans to finance a part of the first ITP projects. This establishes a track record for ITPs projects, lowering the first of a kind risk on such structures for future projects. This can be done through concessional loans that lower overall cost of capital of (early) projects to make them more investable.

International climate finance like the $8.5 billion pledged by rich countries for the Just Energy Transition under the "JET-P" could be one source of this catalytic funding. The international climate finance can be deployed through development banks like the DBSA and the AfDB, applying the instruments discussed above.

05 CONCLUSION

Mobilising capital to scale transmission infrastructure is essential to improve energy security, create jobs and support inclusive growth. Installed generation capacity needs to almost double by 2032 compared to 2022 for achieving a just energy transition. But there is no grid capacity for over 60% of that generation. Unless the use of the existing transmission grid (the network of power stations, transmission lines and substations which transmit energy to businesses and consumers) is optimised and strengthened significantly, there can be no just transition as no more generation capacity can be connected. This not only creates the risk of continued load shedding, but also poses a threat to economic growth in for example hydrogen, electric vehicles and other green industries.

A national strategic program of investment, that builds on South Africa's unprecedented leadership to finance a just energy transition, can help overcome existing barriers. It currently takes 7-10 years to finalise a transmission project, compared to 3-4 years for renewable generation projects. This means new transmission infrastructure, even if building starts today, cannot solve grid connection bottlenecks in the next 3-4 years. With national coordination and targeted investments, transmission grid connection capacity can be unlocked in the short term through optimising use of the existing transmission infrastructure. Simultaneously, the national program can enable fit-for-purpose financing and a strategic vision to ensure investment in the grid is delivered, in the right places and fast enough to avoid delaying financing and connecting of new renewable generation projects.

Off-balance sheet project finance structures can help secure the required access to capital. Capital can be successfully mobilised for transmission infrastructure investments using different models with different degrees of ownership and control. Independent Transmission Projects (ITPs) are likely to be the most successful model to finance transmission grid infrastructure in the short term. ITPs have a proven track record in other emerging economies such as Brazil, India and Kenya, and can be implemented for specific projects, require relatively little regulatory reform and can be tailored to the desired ownership and control structure required by the transmission company.

An efficient and catalytic allocation of public capital could help accelerate the build out of the transmission infrastructure by lowering the cost of capital. This could include concessional loans or development guarantees to ITPs which help mitigate certain timing and investment risks. International climate finance like the $8.5 billion pledged by rich countries for South Africa's Just Energy Transition under the "JET-P" could be one source of this catalytic funding, deployed through development banks like the DBSA and the AfDB.

The solutions presented in this paper have been informed by expert interviews and analysis but require further work and cooperation amongst key stakeholders to be implemented. This work could be embedded in a national strategic program. Optimising the use of the current grid while unlocking capital and overcoming barriers for building new infrastructure requires close collaboration across multiple stakeholders. To optimise the grid today, further work is needed on mechanisms to ensure generation capacity is directed to those places with available capacity and to maximise the amount of generation capacity connected at any specific location. This will for example include co-locating solar and wind, overbuilding renewables and adding batteries while ensuring a just transition for workers through targeted skills programmes. Barriers need to be addressed systematically and capital options assessed. Ultimately, this will require cooperation between the relevant government departments (energy, environment, state owned enterprises etc.), the state-owned utility Eskom, the transmission company, the private sector, workers and communities to be successful at building long-term energy security and economic growth.

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- Brings together leaders from public, private and philanthropic capital with diverse membership
- Tackles barriers across the financial system to fundamentally change how we invest in the SDGs
- Works with private sector champions to unlock capital for the transition to net zero and develop proof points that can be replicated and scaled
- Proven track record with investors and governments; has helped mobilised over $10bn for high impact projects in emerging markets over the past years
- Partners with existing initiatives, to ensure efforts are complementary and coordinated

Origin
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Mission
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Priority
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Additionality
Takes a private sector lens; works closely with other blended finance initiatives to avoid duplication & fragmentation.

Implementation
Works with governments, project developers, investors and other stakeholders to deliver tangible outcomes and act as an accelerator for local initiatives.

Unique peer network
Supports committed “champions” deliver workstreams, implement recommendations, share learnings & replicate proven models, drive operational synergies to reduce transaction costs & accelerate access to capital & pipeline

Impact
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Key research areas

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Energy Transitions

02
Complexity

03
Transdisciplinarity

04
Social-Ecological Systems (SES) and Resilience

05
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The CST collaborates with a wide range of partners within Stellenbosch University, academia, policy, and practice across South Africa, as well as internationally. The Centre's five-year review – providing more detail on its work and impact – can be found at: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www0.sun.ac.za/cst/wp-content/uploads/2022/03/CST-2021-report-25.11.pdf

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