B.A

BatteryMBA

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BESS as Virtual Power Lines: Is BESS a viable solution as Virtual Power Lines?

Overview of Virtual Power lines

Virtual transmission is the utilization of specifically configured battery energy storage systems in place of transmission capacity to provide combinations of capacity, services and capabilities that achieve greater value than traditional solutions [Exhibit 1]. Virtual transmission solutions enable networks to defer or avoid building new lines [Exhibit 2], operate existing lines closer to their thermal limit with active power support and provide additional benefits including added capacity as needed, avoiding excessive construction costs and permitting challenges often associated with new lines. Virtual transmission projects can take the form of single assets, pairs of assets working in tandem (as "virtual transmission lines") to mimic line flows at both ends, or as a portfolio of assets across the system, as with the trio of assets [Exhibit 3].

The value of energy storage comes from its scalability and speed of deployment compared with traditional infrastructure. With detailed power flow simulations and optimization studies, planners can model energy storage's impact on transmission systems and identify where it would best support the

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local grid through direct interconnection, as well as provide positive cascading impacts on adjacent substations via their interconnections.

Storage as transmission offers an array of benefits over conventional transmission infrastructure. Most of the projects are being proposed to increase the system efficiency and reliability across the world known as "virtual transmission" in Australia and "GridBooster" in Germany. A French Utility company has considered a 40MW virtual transmission Line project known as RINGO to attain grid integration of renewable energy and optimise electricity currents. German Grid has massive energy storage of 1.3GW to achieve the grid stability and lower network costs. A publicly owned utility company based in Andhra Pradesh, India has energy storage between 250 MW and 500 MW to add capacity on its transmission network. The Government of Victoria has proposed a single large virtual transmission asset to allow additional import of electricity over Victoria to New South Wales up to 250 MW at peak times [Exhibit 4 and Exhibit 5].

- If a transmission line is regularly running near its thermal limits, energy storage can be deployed to inject power downstream from the congested line. This can enable the network to manage its peak load while deferring or avoiding the need to upgrade the line.
- Energy storage can be deployed as additional transmission capacity, increasing the operational capacity of existing lines. Strategically positioned storage can inject power to ensure grid stability during a contingency, such as when a line trips off.
- On congested transmission lines, energy storage can again be deployed to inject power, with the goal of reducing net load payments or avoiding curtailments, providing benefits to network customers.
- Energy storage can be deployed at the distribution level to support greater penetration of intermittent distributed resources like rooftop solar. The batteries can be placed on the network, injecting both real and reactive power to manage "voltage stiffness," which can restrict how much solar can be integrated at the feeder level.
- Lastly, storage can provide familiar capabilities like frequency response or other reliability standards at the transmission level – similar to the Fast Frequency Response or "synthetic inertia" service being procured by the grid operator in Ireland – to improve overall transmission reliability.

The development of BESS as virtual power lines will depend on the technological developments, energy storage demands, transmission capacity, congested transmission lines, the policy and regulatory frameworks across countries. Recently, South African Utility company, Eskom has developed a 343 MW battery storage project in remote locations with limited access to distribution networks but in proximity to large scale renewable energy power plants. Further, Australia has continued to evaluate battery-based options for adding more capacity on the interconnectors between the states compared to the typical 5–10-year timelines for traditional infrastructure projects.

Case Study Instructions

We are a TSO company, which operates in South Africa and we are open to explore additional countries for business expansion. As a Transmission System Operator, considering the pros and cons of BESS and OHL, should TSO invest in traditional OHL or BESS as Virtual Power Lines?

Transmission System Operator (TSO) - Entity entrusted with transporting energy or electrical power on a national or regional level from generation plants over the electrical grid to regional or local electricity distribution operators. The role of TSO is to manage the security of the power system in real time and coordinate the supply and demand of electricity, in a manner that avoids fluctuations or interruptions in the supply.

Questions to be addressed while making the decision by TSO are as follows:

1. Is BESS an economically viable option as a transmission solution in the South African market? Why?
2. What higher risks are being posed if TSO proposes to adopt BESS as VPL model?
3. What is the price reduction (in %) needed of batteries that makes VPL cheaper than OHL?
4. Considering the Australian Energy Market Operator (AEMO) initiatives for significant upliftment of batteries, should TSO invest in BESS as VPL in the Australian market for better returns?

Applications of BESS on transmission lines

Managing Peak Load: When a transmission line is near its thermal limits, energy storage can inject power downstream of the congested line, helping manage peak load and potentially deferring or avoiding line upgrades.

Arbitrage: Reduces electricity costs by systematic arbitrage of energy prices. Storing energy during off-peak, low-price periods and providing it during high-price periods can profitably alleviate strain on the grid during periods of high demand and reduce the need for expensive peaking power plants. Momentary and short-period peak pricing can increase by 10x and even 100x, offering significant returns for fast switchable supply/virtual generators.

Increasing Capacity: Energy storage can act as additional transmission capacity, enhancing the operational capacity of existing lines. Strategically placed storage can inject power to maintain grid stability during contingencies, such as line trips.

Reducing Congestion: On congested lines, energy storage can inject power to reduce net load payments or avoid curtailments, benefiting network customers.

Supporting Distributed Resources: At the distribution level, energy storage can support higher penetration of intermittent distributed resources like rooftop solar. Batteries can be placed on the network to inject real and reactive power, managing “voltage stiffness” and allowing more solar integration at the feeder level.They stabilise microgrid operations by automatically balancing supply and demand, regulating frequency and mitigating voltage sag or rise.

Frequency regulation: Storage can provide capabilities like frequency response or other reliability standards at the transmission level, similar to the Fast Frequency Response. These systems are instrumental in frequency keeping, by responsively injecting or absorbing power as required. BESS can rapidly respond by consuming or discharging energy to impose balance on the supply. By providing bidirectional fast-response load/capacity, BESS reduces reliance on spinning reserve and fast-start thermal sources for frequency keeping, thereby lowering emissions. BESS’s key capability is enabling the grid to seamlessly and fully integrate renewable energy sources (transient and junk power) by buffering their variability.

Dr. Q Wang from the University of Houston published a study [4] evaluating the performance and economic benefits of using a BESS as VPL considering operation cost, network congestion, model computational time and market performance in California ISO.

Project Timelines

The construction of a new high-voltage overhead transmission line in South Africa typically takes between 3 to 10 years from planning to commissioning. This time includes planning, getting approval from authorities, construction and testing and commissioning. The exact time is hard to predict because it depends on many factors [1]. In September 2024 Eskom published plans to add 800km of transmission and distribution lines in the next 36 months [2], which suggests it can be done within 3 years. Upgrading an existing transmission line is expected to take less time than constructing a new line.

Historical construction times of BESS systems vary. For example, in Australia the 50MW/100MWh Bouldercombe BESS took 23 months from financial close to full operation, the 100MW/150MWh Wandoan BESS took 19 months for the same period, the 100MW/200MWh Chinchilla BESS was only partially operational after 25 months since financial close, and the same was true for the 100MW/200MWh Capital BESS after 17 months [3]. See Exhibit 8 for more examples of BESS construction times.

Department of Mineral Resources & Energy (DMRE) public tenders for BESIPPPP

The BESIPPPP programme aims to procure 513 MW of capacity and ancillary services in South Africa's Northern Cape, a region rich in solar resources. The first two projects under this programme, Mogobe BESS and Oasis Mookodi, have reached commercial close, marking a significant milestone as the first standalone grid-scale battery energy storage projects in the country [12]. These projects, with a combined capacity of 180 MW/720 MWh, will enhance grid stability and support renewable energy integration. Construction is expected to be completed by September 2026. Exhibit 9.

The Department of Mineral Resources and Energy has invited bids for the second bid window of the Battery Energy Storage Capacity Independent Power Producers Procurement Programme (BESIPPPP Bid Window 2). This programme aims to procure 615 MW of capacity, energy, and ancillary services in the North West supply area, with all relevant substations located in this region. Exhibit 10.

The BESIPPPP Bid Window 3 aims to procure 616 MW of capacity, energy, and ancillary services in the Free State supply area. All substations involved in this programme are located within the Free State region. Exhibit 11.

Commercial Sense of Utility Scale BESS vs OHL

For the purpose of this case study a techno-commercial analysis was performed on a 100 MW/100 MWh 1h utility scale BESS system in the South African market.

CAPEX and OPEX

Recent market data from established Chinese EPC contractors & BESS-OEM suppliers have been captured for the purpose of this evaluation based on pricing data from Q3 2024.

The total CAPEX of such a BESS system is about USD 23M, and 15 years of OPEX is about USD 8M, totalling about USD USD 31M. Details can be found in Exhibit 12.

CAPEX data on typical selected overhead transmission lines deployed in the South African market have been examined. 132 kV voltage level OHL has been selected as it's the typical voltage used to evacuate renewable energy generators with a maximum capacity of 240 MW. OHL length of 100 km has been selected as it's the typical maximum distance between RE generators either wind or Solar PV power plants from the connection point which is the nearest main transmission substation (MTS) in NTC-SA-national transmission company of South Africa (Eskom)

The total CAPEX of such an OHL is about USD 20M, and 15 years of OPEX is about USD 7.5M, totalling about USD 27.5M for 15 years of operation. Details can be found in Exhibit 13.

BESS revenue advantage

The BESS has a revenue advantage over the OHL: it can use time-shifting, i.e. buy (and store) energy at low demand/price and sell at peak demand/price. At the current electricity rates that would amount to a revenue of up to USD 4.8M per year (for one full charge/discharge per day) [Exhibit 14]. Assuming that the construction time of a BESS is about 2 years shorter than for an OHL, the BESS can already leverage this revenue while the OHL would still be in the construction phase. This would give an extra revenue of up to USD 9.6M, which we can deduct from the total BESS cost when comparing to the OHL. A single BESS system net cost would then be about USD 21M.

A further revenue advantage might be obtained by using the BESS for reducing the curtailment of renewables. How much this will be is hard to predict because it depends very much on when the renewable energy is produced.

BESS as VPL Pain-points

While developing BESS as a virtual transmission asset one faces several obstacles including regulatory / market Issues and technological challenges.

Regulatory Issues

Currently, there are unclear local or regional regulations governing how the transmission companies can own the storage systems. Companies are unaware about the limits for storage ownership. In many regions, we have seen that the rules are designed for Poles and wires and synchronous generation, however, there are missing links considering that batteries could also provide these functions.

Market-based revenue issues

There is no clarity on generating market-based revenue streams which lead to competition between transmission utility operators and generators. This is a major area of concern as storage in transmission or distribution applications are new and often difficult to determine. In certain regions, the regulated assets revenue streams must need approval by regulators which may add significant proposal and approval time to the project. The transmission operators may be able to access or provide the services through their assets that they could not provide access through assets owned by generators. This led to major competition between service providers and generators.

Technical concerns

From a technology perspective, battery-based energy storage may require overbuilding for transmission applications, with redundant system layouts or extra capacity to ensure the desired level of availability and services. While developing high powered batteries, this could add cost to the generation assets.

Government support for development of BESS projects

BESS projects status in South Africa

In the last three years the South African government has supported the growth of the BESS industry landscape in South Africa due to the deep need to integrate large amounts of renewable energy generation capacity additions and to alleviate the supply side shortage affecting the electric grid with frequent load shedding in previous years.

The adoption of BESS projects by national utility Eskom together with the ambitious public tendering program BESIPPPP will add GW scale BESS projects to the SA grid within the coming 2-3 years.

Government Incentives for BESS Projects in Australia

BESS is the key to Australia and the world transitioning to 100% renewable energy. The Australian government recognises the benefits of BESS and has been supporting BESS initiatives in the country. Acting through Australian Renewable Energy Agency ARENA, $100million has been provided in government grants towards large-scale battery energy storage projects. In the year 2021, BESS market had a record-breaking year surpassing 1GWh annual battery storage deployments, enough energy to power ~750,000 homes. Another similar installation is underway, predicting 33,000 home energy storage sales and 750MWh of grid scale storage in Australia. As a transmission network planner for Victoria, AEMO recently completed a Regulatory Investment Test for transmission (RIT-T) to assess the technical and economic viability of increasing transmission network capacity to address the current limitations in transmission network. Virtual transmission – batteries can lift the existing capacity of the grid. NSW is already using this opportunity to uplift transmission capacity in its existing transmission system.

South African Utility (Eskom-NTC-SA) projects (turn-key)

In August 2022 South African utility Eskom has selected contractors for 343 MW of battery storage projects to be deployed in remote locations with limited access to distribution networks, but in proximity to large-scale renewable energy power plants.

Eskom's multi-site project represents the first part of a 500 MW BESS initiative announced by President Cyril Ramaphosa, under the government's measures to address South Africa's long-running electricity crisis.

The buildout will include large-scale batteries with capacities of 1,440 MWh per day and 60 MW of solar PV, which will be implemented in two phases across 12 sites in South Africa. The first phase will include the installation of around 199 MW/833 MWh of battery storage projects alongside 2 MW of solar PV, while the second phase will involve the rollout of 144 MW/ 616 MWh of battery capacity and 58 MW of solar PV.

The distributed battery storage projects will be located in remote areas with limited access to Eskom's distribution network, but close to renewable energy plants operating as independent power producers (IPPs), the utility said. First-phase projects are scheduled for commissioning by June 30, 2023, while the second phase is expected to follow by December 2024. The rollout will be co-financed by the African Development Bank, New Development Bank, the World Bank, and the Clean Technology Fund (CTF) [13]. Details of the operational parameters of the various BESS sites in phase 1 and 2 are given in Exhibit 15 and Exhibit 16 respectively.

Conclusions

Going through the scenario of a South African company wherein they have developed a project for BESS as VPL having total capital plus 15-year operational expenses for VPL-BESS system 13% higher for a single BESS system and 127% higher for a double BESS system, compared to the equivalent costs for a 100km-132kV OHL. However, due to the shorter construction time of a BESS, extra revenue can be generated compared to OHL, which then makes the single-BESS system up to 22% *cheaper* than the OHL, but a double BESS system still 57% more expensive than the OHL. The net cost of the BESS systems could potentially be further reduced by revenue from the reduced curtailing of renewables.

As the world shifts towards green energy production. The need for utility scale energy storage is growing to balance power demand and generation. In particular, batteries are very useful for maintaining grid stability, reliability, sharing peak loads and deferral of transmission lines in [Exhibit 6]. Apart from the recent trends, technological advancements, battery technologies are likely to evolve and witness further developments in energy density, cost reduction, and safety configurations.

The main questions are:

1. Is BESS an economically viable option as a transmission solution in the South African market? Why?
2. What higher risks are being posed if TSO proposes to adopt BESS as VPL model?
3. What is the price reduction (in %) needed of batteries that makes VPL cheaper than OHL?
4. Considering the Australian Energy Market Operator (AEMO) initiatives for significant upliftment of batteries, should TSO invest in BESS as VPL in the Australian market for better returns?

Many other questions still remain unanswered as the battery costs will reduce in near future in different geographies of the world. Technological advancements will have an impact on the overall economies of BESS. How would battery energy storage solutions as virtual power lines look like in 10 years? How the economies of scale may change the idea of Virtual power lines with more and more subsidies introduced in the industry? Are there any other options beyond Virtual Power lines from battery swapping and V2G and more..?

How will Transmission system operators respond to the ever-evolving battery-based technology?

Abbreviations

AEMO: Australian Energy Market Operator

ARENA: Australian Renewable Energy Agency

Augmentation: Increasing the battery's energy capacity. This could be repowering a system following degradation or a commercial decision to increase the project's duration.

BESIPPPP: Battery Energy Storage Independent Power Producer Procurement Program

BESS: Battery Energy Storage System

CAPEX: capital investment costs

EPC: In charge of engineering, procuring and constructing the OHL or BESS.

IPP: Independent Power Producer

LTSA: Long Term Service Agreement

NSW: New South Wales

OPEX: operational costs

RIT-T: Regulatory Investment Test for transmission (Govt initiative)

TSO: Transmission System Operator - Entity entrusted with transporting energy or electrical power on a national or regional level from generation plants over the electrical grid to regional or local electricity distribution operators.

V2G: Vehicle-to-Grid, i.e. using batteries in cars as storage for the grid.

VPL: Virtual Power Line

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2) Eskom, *"State of the System Summer Outlook"*, https://www.eskom.co.za/wp-content/uploads/2024/09/20240826_State-of-the-system_Summer-Outlook.pdf

3) Dan Lee (WattClarity), "*Need for speed: How long has each battery project in the NEM taken to deliver?*", https://wattclarity.com.au/articles/2024/03/need-for-speed-how-long-has-each-battery-project-in-the-nem-taken-to-deliver/

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11) Eskom Media statement, *"Eskom appoints service providers for its battery energy storage project"*, https://www.eskom.co.za/eskom-appoints-service-providers-for-its-battery-energy-storage-project/

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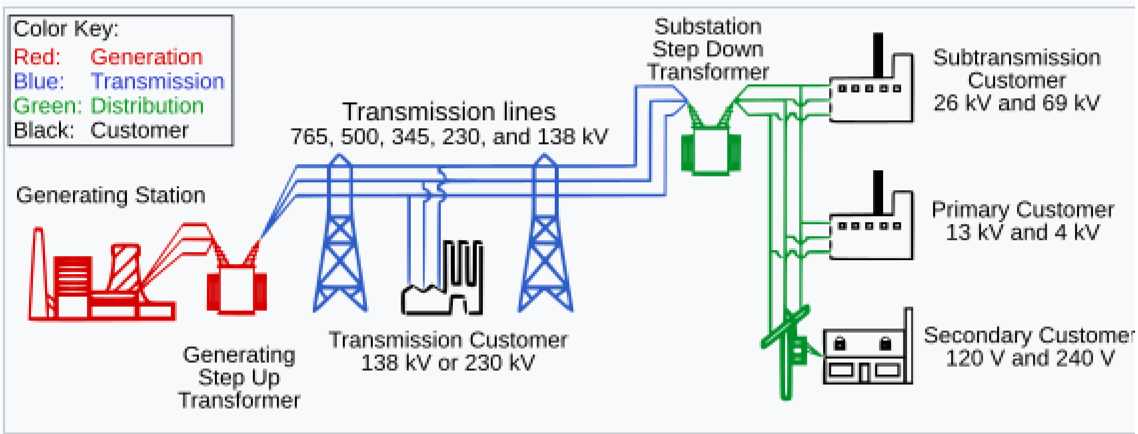
15) https://www.fortunebusinessinsights.com/industry-reports/battery-energy-storage-market-100489
16) https://info.fluenceenergy.com/hubfs/Building%20Virtual%20Transmission.pdf

Exhibits

Exhibit 1: Traditional Transmission and distribution of power from generation plants to consumers



Simplified diagram of AC electricity grid from generation stations to consumers in North America

Exhibit 2: Deferral of new built transmission Line

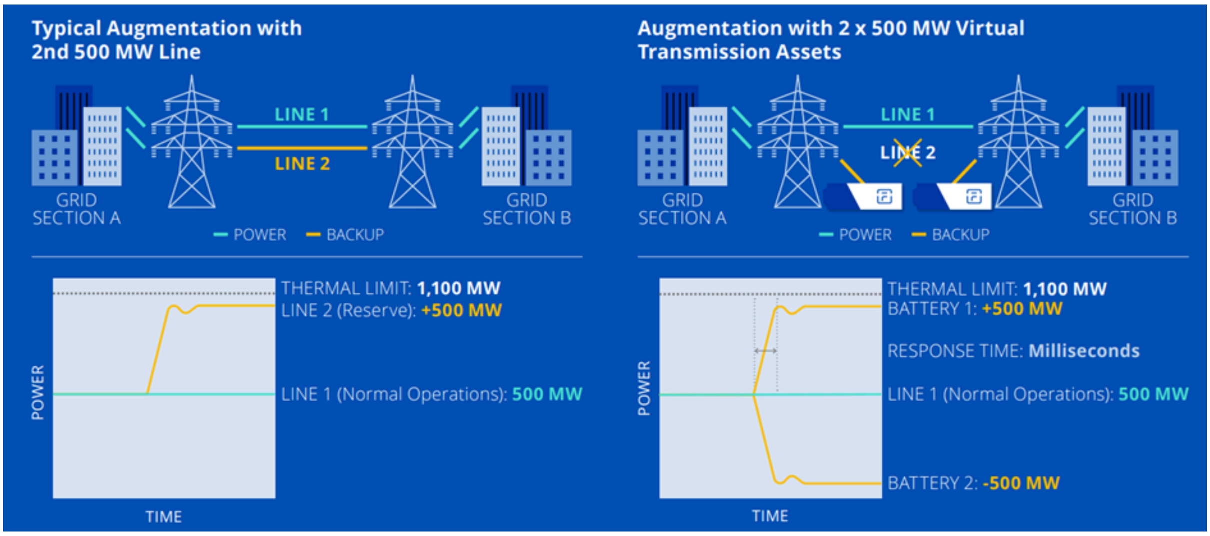
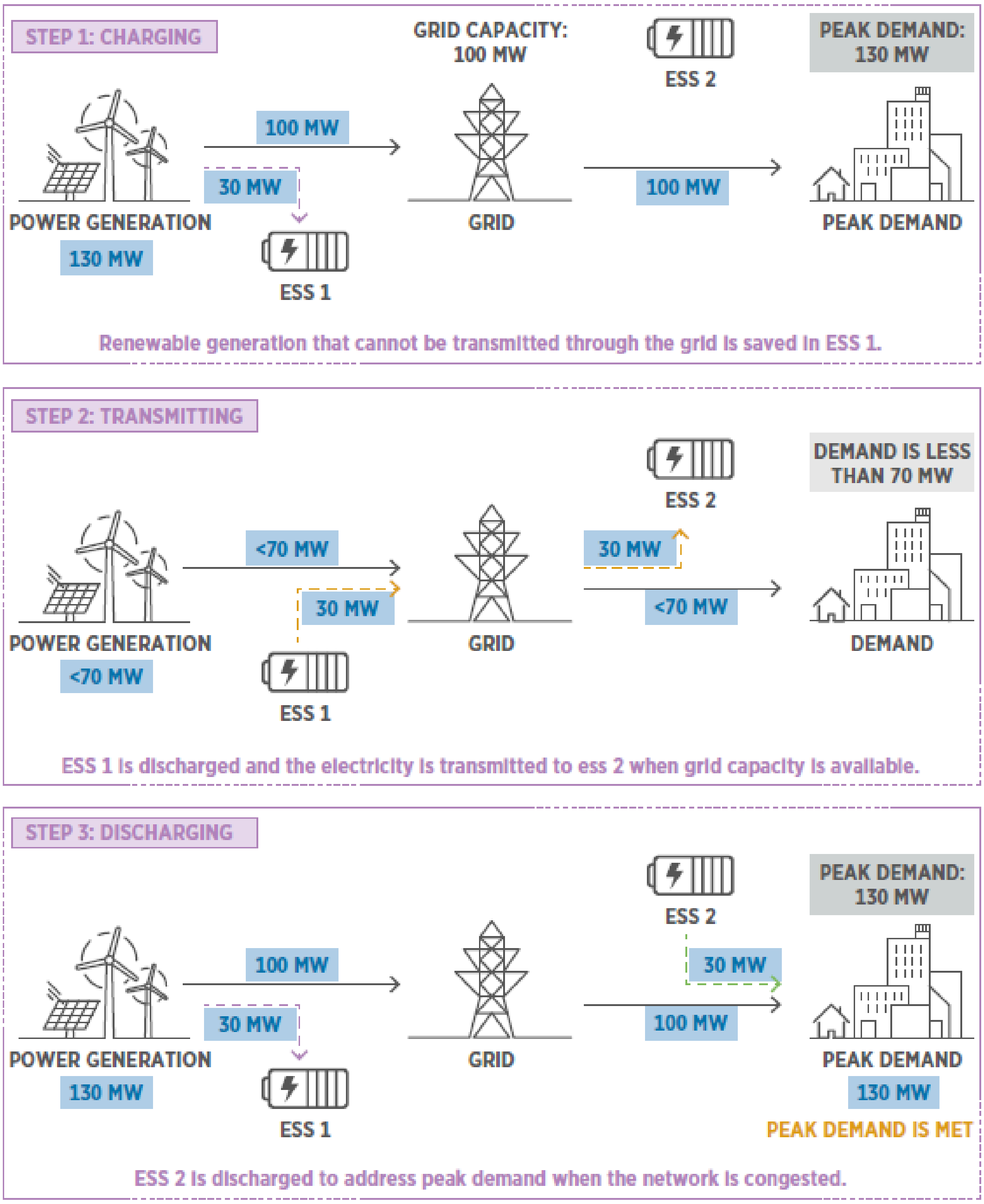


Exhibit 3: How does Virtual Power line work?



Note: MW = megawatt.
Source: Adapted from ENTSO-E (2016).

Exhibit 4: Storage as transmission projects currently considered and/or constructed across the Globe

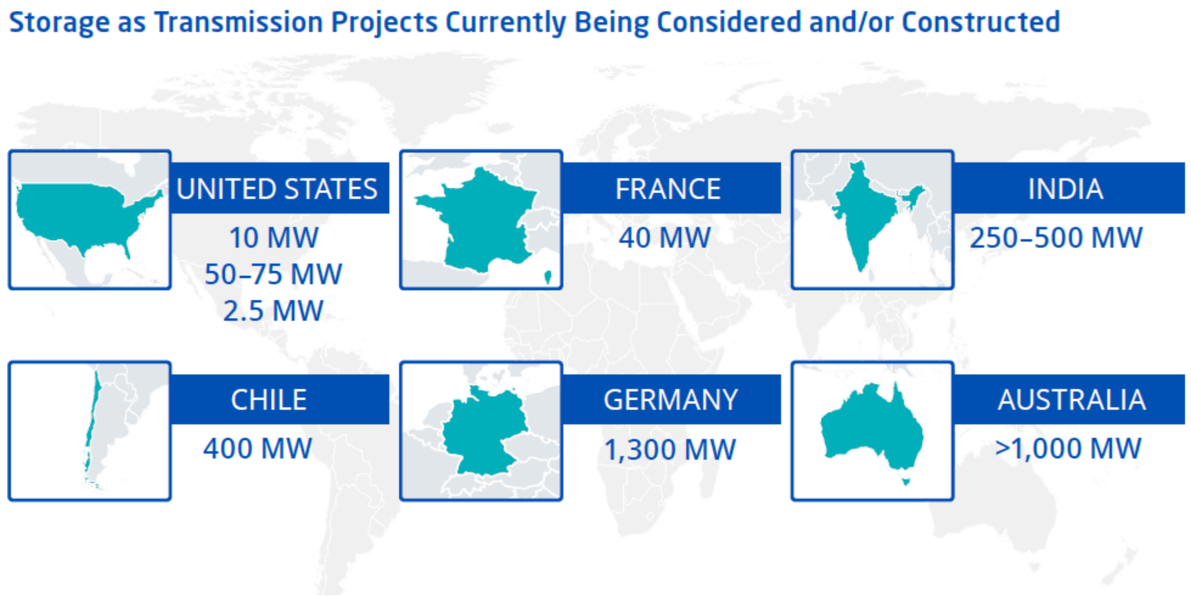
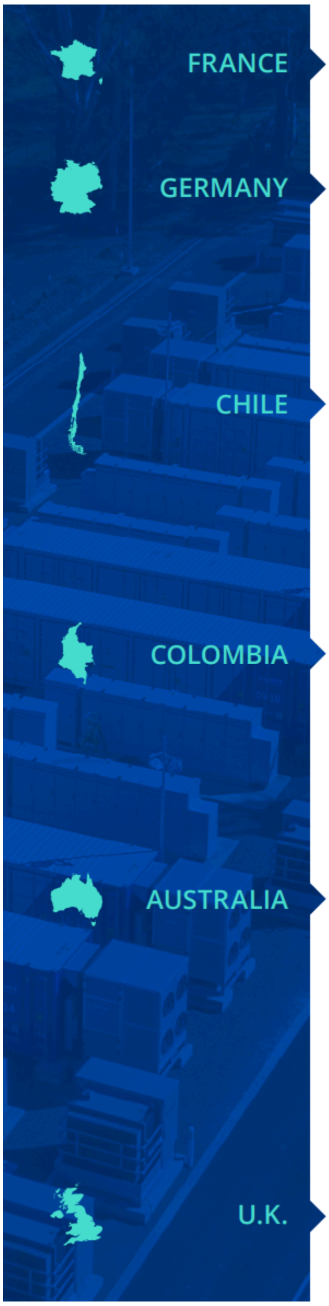


Exhibit 5: Virtual Power Line Transmission Projects across the Globe



IN FRANCE, a three-asset portfolio totaling 32 MW/98 MWh, dubbed Project RINGO, is under construction for RTE's network for completion in 2020. This pilot project is focused on congestion management at the transmission system level.

IN GERMANY, an unprecedented 1,300 MW portfolio of energy storage known as "GridBooster" was proposed in 2019 to ensure grid stability and lower network (i.e., redispatch) costs. As a first phase, three projects totaling 450 MW have been approved for procurement by TransnetBW and TenneT to provide backup transmission capacity, as opposed to the grid operators maintaining an entire additional transmission line on standby to provide N-1 contingency relief.

IN CHILE, AES Gener, in consultation with Fluence, has proposed 500 MW to the 2020 National Transmission Expansion Plan. Deployed in blocks of 100MW along two different transmission corridors, these systems will release capacity on the lines by providing N-1 contingency relief with batteries instead of additional lines. Employing the same methodology used for proposed poles-and-wires transmission projects, AES Gener found that the capacity additions would provide an expected net present value of US$400 million to the national grid dispatch costs.

IN COLOMBIA, the Ministry of Energy issued a public tender for a 50MW/50 MWh virtual transmission asset. Congestion in the Atlantico region, where transmission upgrades have been challenging to permit, is causing increased network costs as out-of-merit generation is dispatched to ensure system reliability. The virtual transmission asset will relieve that congestion and increase the regional grid's flexibility by providing N-1 contingency relief. This will allow grid operators to dispatch the lowest-cost energy generators while maintaining reliability.

IN AUSTRALIA, multiple projects are under consideration.

- The government of Victoria is working to procure a single large virtual transmission asset under its System Integrity Protection Scheme (SIPS), to allow additional import of electricity over the Victoria to New South Wales Interconnector (VNI) of up to 250MW at peak times.
- Separately, in response to the Australian Energy Market Operator's call for non-network options to upgrade the VNI, Fluence submitted a proposal to deploy two 250 MW virtual transmission assets to work in tandem, which together would add 250 MW of bidirectional transmission capacity to the line.

IN THE UNITED KINGDOM, National Grid is working to procure 200 MW of flexible resources to mitigate congestion and facilitate higher power flows on the existing UK grid, notably along the England-Scotland border.

Exhibit 6: Traditional Approach for transmission vs New Enhanced Approach of Transmission

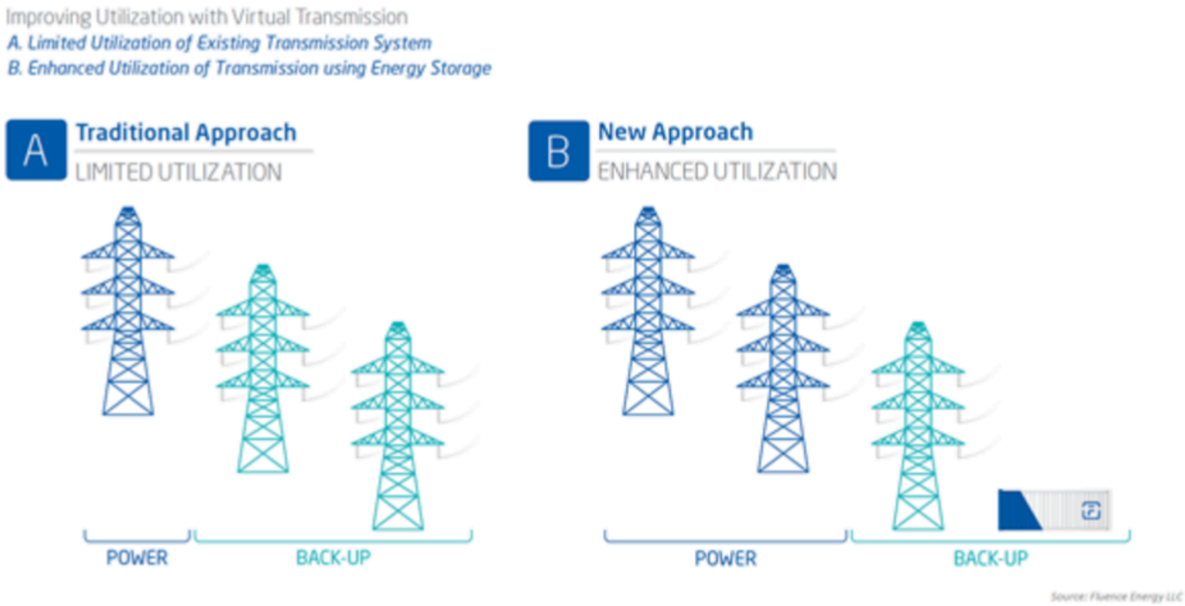
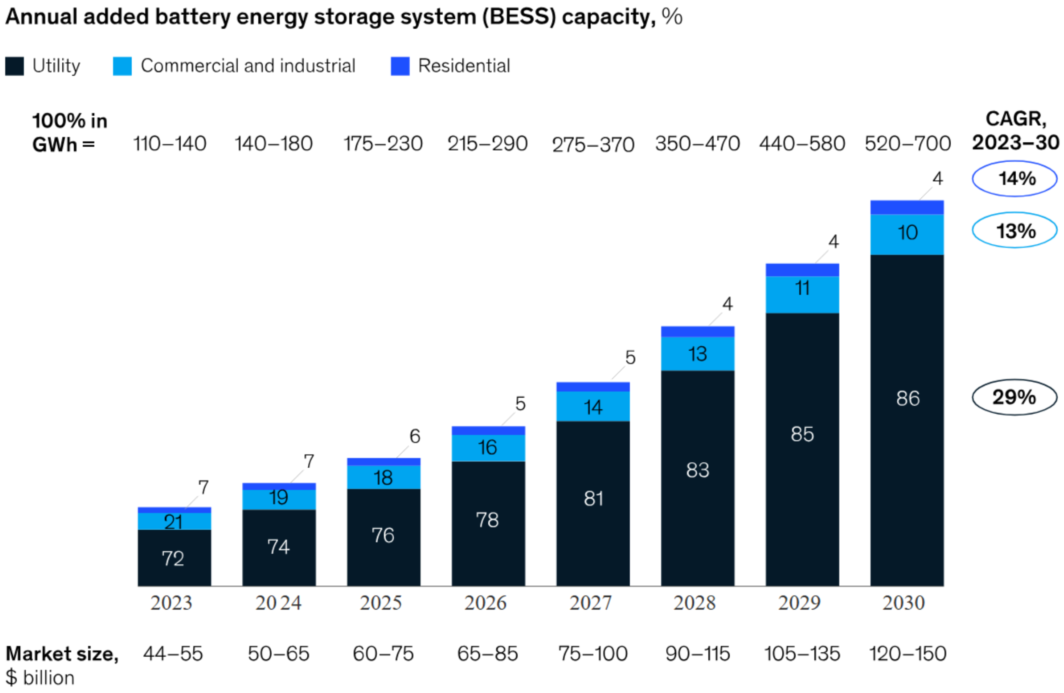


Exhibit 7: Energy Storage insights and future projections for BESS



Note: Figures may not sum to 100%, because of rounding.
Source: McKinsey Energy Storage Insights BESS market model

McKinsey & Company

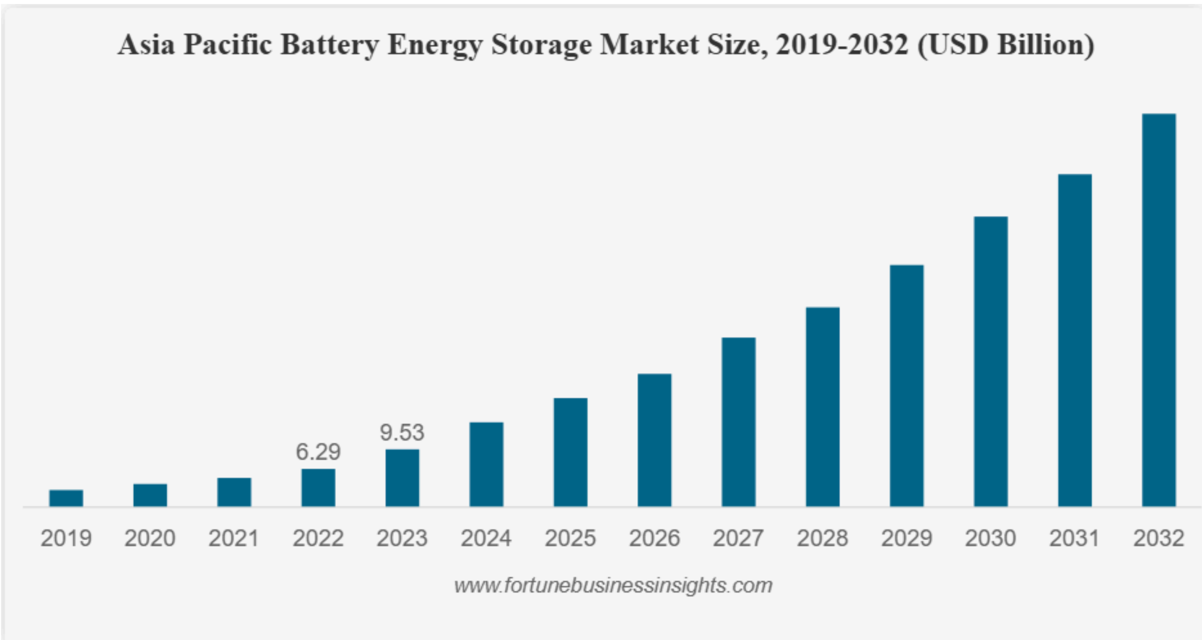
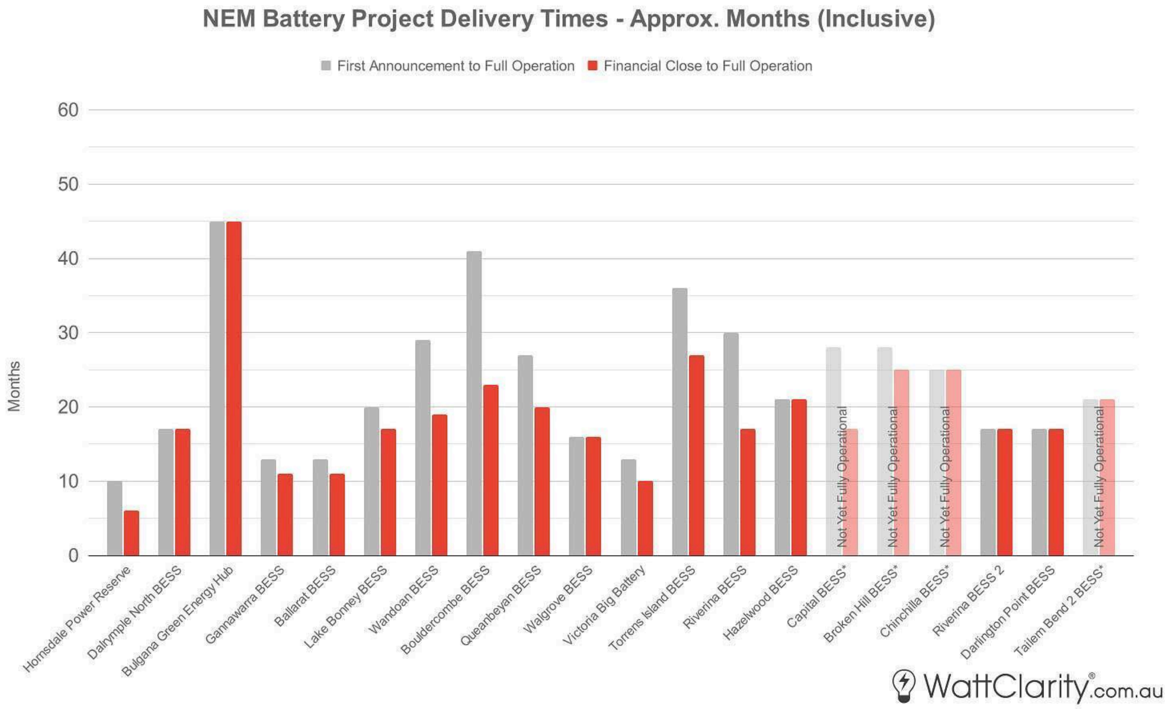


Exhibit 8: Project delivery times for each BESS in Australia.



With the following definitions:

- **First Announcement**: Marks the date that the company first publicly unveiled the project. Feasibility studies, contract negotiations and detailed design work typically begin before this point in time. This is a notable milestone as it is a signal of when the market, and system planners generally start to anticipate the project.
- **Financial Close**: Date of Financial Close or Final Investment Decision for the project, or in the case of Government-initiated contracts, the date when 'notice to proceed' was given.
- **Full Operation:** Marks when the battery's generation or load DUID maximum daily availability was at its full capacity for more than half of a calendar month. Or where more appropriate, the first month of material FCAS bidding. I have used our GSD2023 data extract to determine these dates.

Source: [Dan Lee (WattClarity), "Need for speed: How long…].

Exhibit 9: Transmission substations maximum capacity for BESIPPPP Bid Window 1.

Transmission Substation	Maximum Capacity
Aggeneis	77 MW
Ferrum	103 MW
Garona	153 MW
Mookodi	77 MW
Nieuwehoop	103 MW
Total	**513 MW**

Exhibit 10: Transmission substations maximum capacity for BESIPPPP Bid Window 2.

Transmission Substation	Maximum Capacity
Mercury	76 MW
Carmel	77 MW
Hermes	77 MW
Ngwedi	77 MW
Midas	77 MW
Marang	77 MW
Bighorn	77 MW
Ararat	77 MW
Total	**615 MW**

Exhibit 11: Transmission substations maximum capacity for BESIPPPP Bid Window 3.

Transmission Substation	Maximum Capacity
Harvard	123MW
Leander	123 MW
Theseus	124 MW
Everest	123 MW
Merapi	123 MW
Total	**616 MW**

Exhibit 12: CAPEX & OPEX for selected 100 MW/100 MWh 1h utility scale BESS system in the South African market-Q3-2024.

BESS Technology	LFP
BESS Supplier	CATL/Sungrow/Trina/Hithium or equivalent
BESS Usage	Peak Shaving-1h
Contracted Power Capacity (MW)	100.0
Contracted Energy Capacity (MWh)	100.0
Initial Installed Capacity (MWh)	120.0
Augmentation Capacity -15 years (MWh)	36.0
CAPEX (USD/MWh)-EPC Cost	$ 154,875
Total Initial CAPEX (USD)-EPC Cost-2024	$ 18,585,000
Augmentation CAPEX (USD/MWh) *Projected 30% reduction in Battery container cost & 20% reduction in total EPC cost as compared to 2024 CAPEX figures	$ 123,900
Total Lifetime Augmentation CAPEX (USD)	$ 4,460,400
Lifetime LTSA costs-15 years (USD)	$ 467,185
Total Warranty extension (Y4-Y15)	$ 2,309,298
BESS Plant BOP maintenance costs (USD/MWh/annum)	$ 1,000

Total BESS Plant BOP maintenance 15Y	$ 2,232,000
Asset management costs per annum	$ 200,000
Asset management costs 15Y	$ 3,000,000
CAPEX+OPEX	$ 31,053,883

Exhibit 13: CAPEX & OPEX for a 132kV-100 km overhead transmission line in the South African market

OHL type	132kV single circuit tern/kingbird conductor
CAPEX (ZAR/km)	3,500,000.00
CAPEX (USD/km)	198,300
OHL length (km)	100.00
Total CAPEX (USD)	**19,830,028**
OPEX USD/km/year	5,000
Total OPEX -O&M costs USD/year	500,000
Project lifetime OPEX-15 years (USD)	**7,500,000**
CAPEX+OPEX	**27,330,028**

Exhibit 14: Time-shifting revenue for single BESS system.

Value of energy tariff difference (ZAR/MWh) average high/low demand season Megaflex tariff (1683 ZAR/MWh) -IPP BESS develoeprs generator input tariff (519 ZAR/MWh)	ZAR 1.164
Value of energy input tariff -Total -ZAR/year	ZAR 84.972.000
Value of energy input tariff -Total-USD-12 months	USD 4.814.278
Value of energy input tariff -Total-USD-24 months	USD 9.628.555
Total CAPEX+OPEX+Energy opportunity costs-1 BESS system	$ **21.425.328**
Total CAPEX+OPEX+Energy opportunity costs-2 BESS systems	$ **42.850.656**

Exhibit 15: Operational parameters of Eskom BESS sites for Phase 1.

Name	Distribution OU	MW Output	MWh capacity	PV capacity
Skaapvlei	WC	80	320	0
Melkhout	EC	35	140	0
Elandskop	KZN	8	32	0
Pongola	KZN	40	160	0
Hex	WC	20	100	0
Graafwater	WC	5	30	0
Paleisheuwel	WC	9.5	45	0
Rietfontein	NC	1.54	6.16	2.04
Total Phase 1		**199.04**	**833.16**	**2.04**

Source: [Eskom Media statement, "Eskom appoints service providers for its battery...]

Exhibit 16: Operational parameters of Eskom BESS sites for Phase 2

Project Name	Distribution OU	MW output	MWh Capacity	PV capacity
Witzenberg	WC	17	68	0
Ashton	WC	17	68	0
Cuprum	NC	70	280	0
Kiwano	NC	40	200	58MW
Total Phase 2		**144**	**616**	**58MW**

Source: [Eskom Media statement, "Eskom appoints service providers for its battery...]