The Integration of Renewable Energy and Energy Storage Systems in Smart Grids Within the South African Energy Market

Omaira Jajbhay – Electrical Engineer (Zutari)

INTRODUCING
OMAIRA JAJBHAY

Omaira is an electrical engineer at Zutari, currently pursuing her MSc in Electrical Engineering – in *Optimizing Renewable Energy Integration and Energy Storage in Smart Grids Through Advanced Forecasting Models*. She has an excellent understanding of electrical engineering concepts, especially power systems and renewable energy, with exceptional power system protection and solar power knowledge. She has been involved in several local and international renewables and protection projects, which were located in Malawi, Kenya, Uganda, Ghana, Sierra Leone, Australia and Saudi Arabia. She has also served as project manager and lead design engineer for the University of Cape Town's Solar PV project, amongst many other projects with key involvement roles.

Her achievements include international recognition in renewable energy winning the BRICS 2023 Future Skills Challenge in the Renewable Energy Category, the first of its kind for South Africa, SAIEE National Engineering Excellence Award 2023, SAIEE KZN Centre Women in Engineering Award 2023, as well as merit achievements in university. She was previously the Chairperson of SMEC Western Cape Young Professionals Forum and is currently a CESA YPF KZN Representative. She was also one of the panel members in the Durban Innovate Youth Innovation Challenge providing her insights for design thinking workshops and judging innovations during the pitching den (2023). Omaira was also a guest speaker at the UKZN EECE Open Day Awards 2023. Omaira is also a panel member for SAIEE KZN Branch and was a keynote speaker for the SAIEE on *" building eminence in the engineering profession"*.

Omaira has always contributed to meaningful impacts whether in her community or career. Omaira is a young engineer that aspires to inspire and lead the way for future generations especially engineers, the youth and women in STEM.

CESA
Consulting Engineers South Africa

YPF
Young Professionals Forum

Introduction

- SA Energy Landscape
- RE Market in SA
- Smart Grids
- Integration of RES and ESS in SGs
- Challenges and Solutions
- Case Studies

SOUTH AFRICAN ENERGY LANDSCAPE

Current Energy Landscape in South Africa

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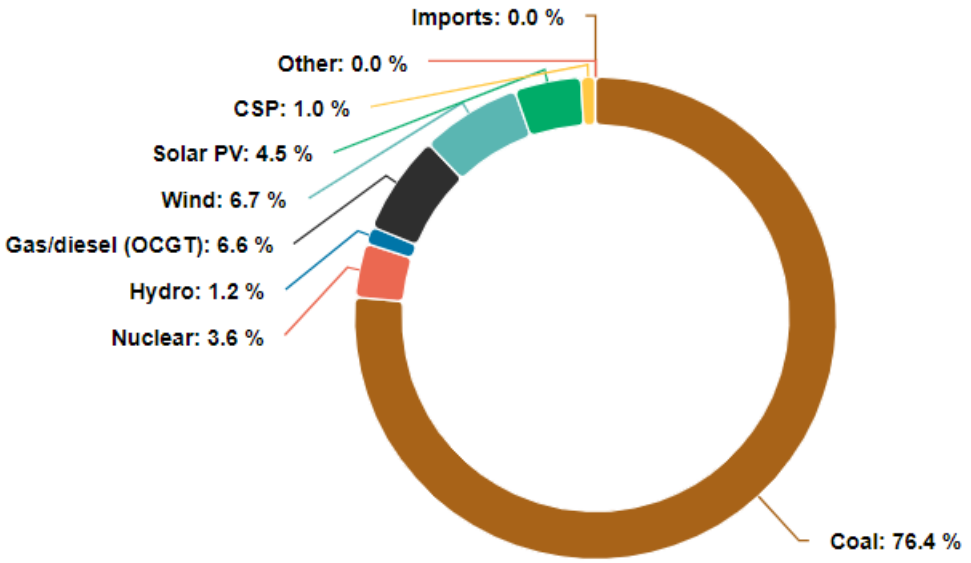
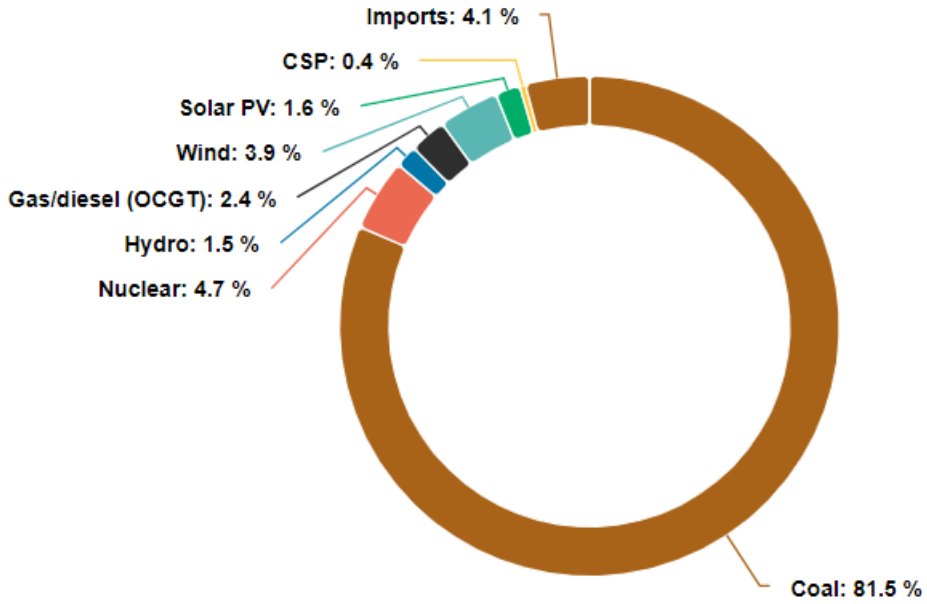
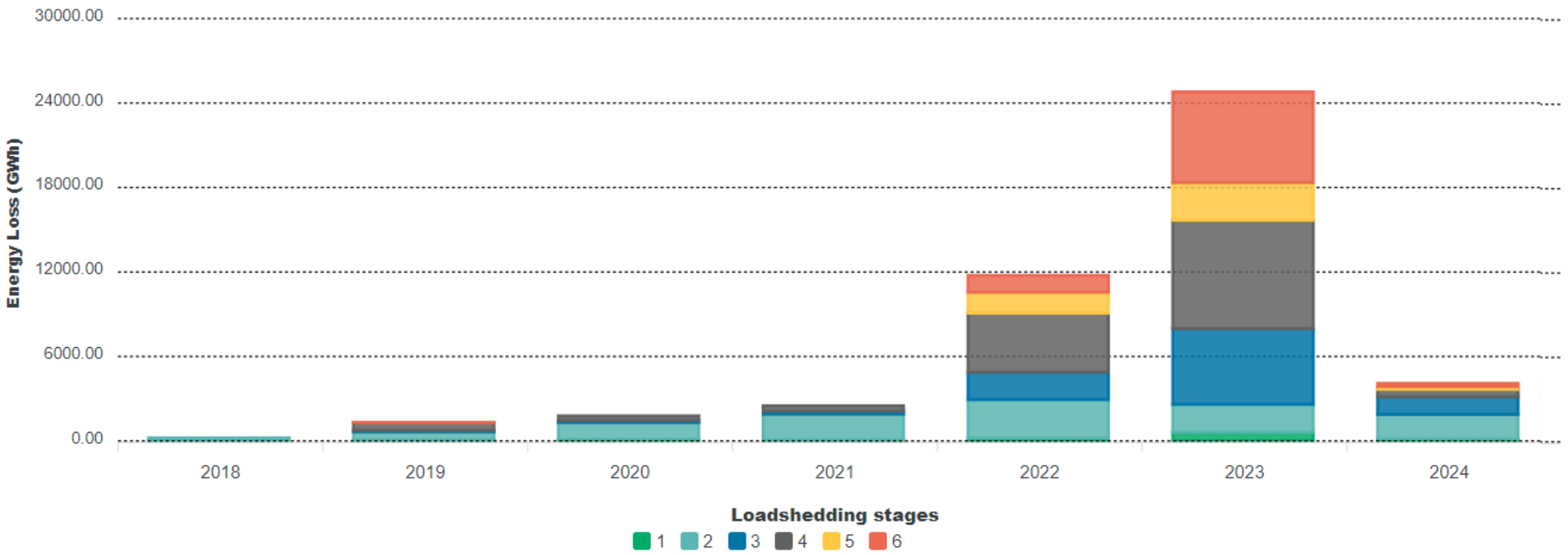
Installed Capacity (GW)



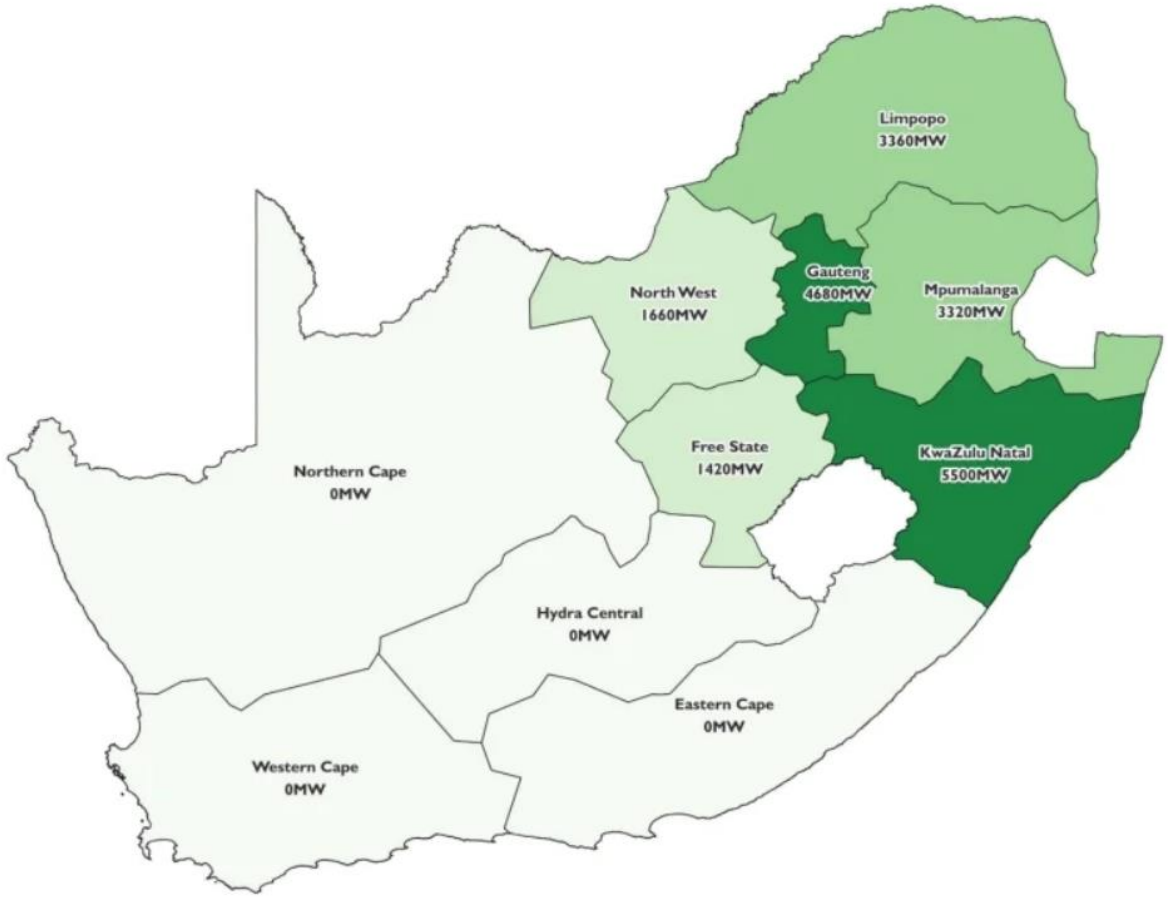
Energy Contribution (GWh)



Rolling Blackouts



Grid Constraints



RENEWABLE ENERGY MARKET IN SOUTH AFRICA

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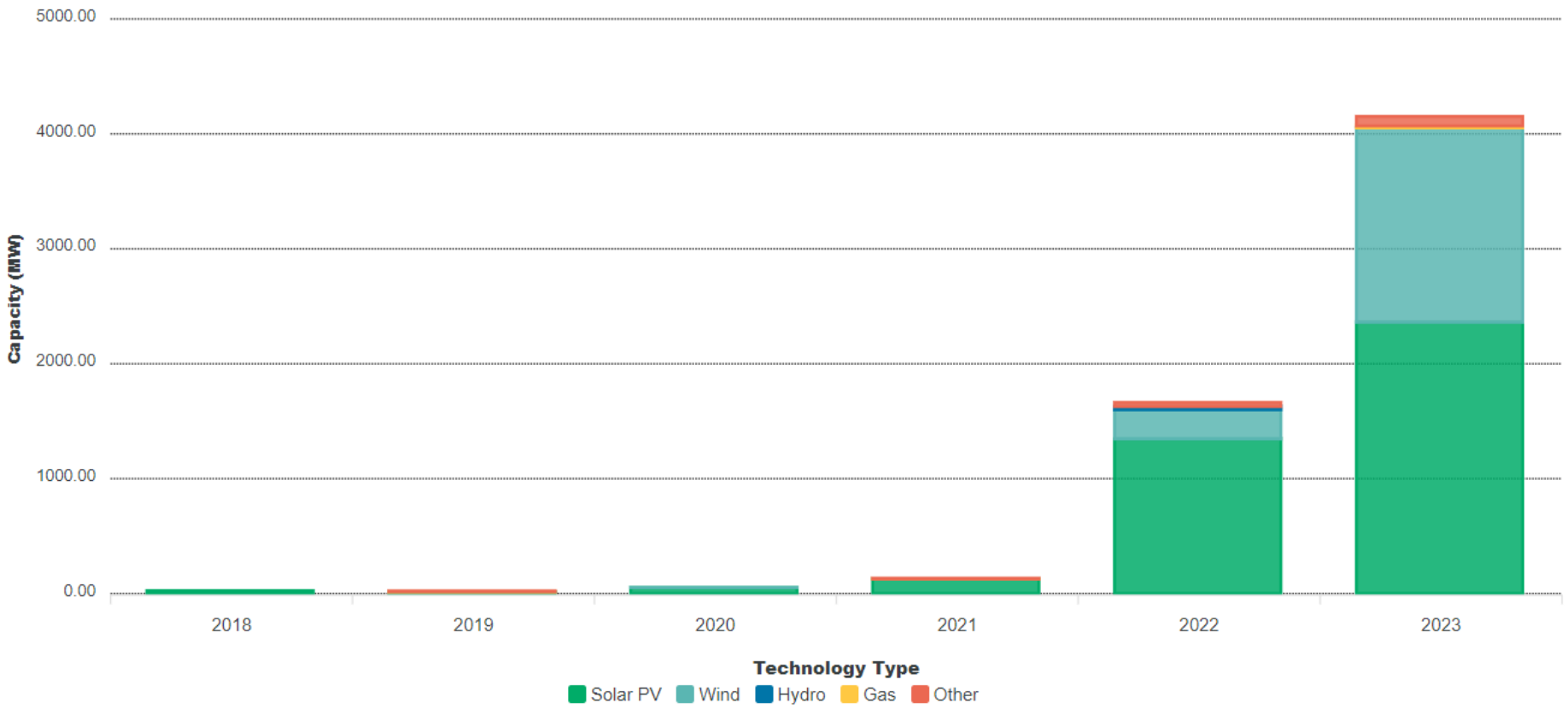
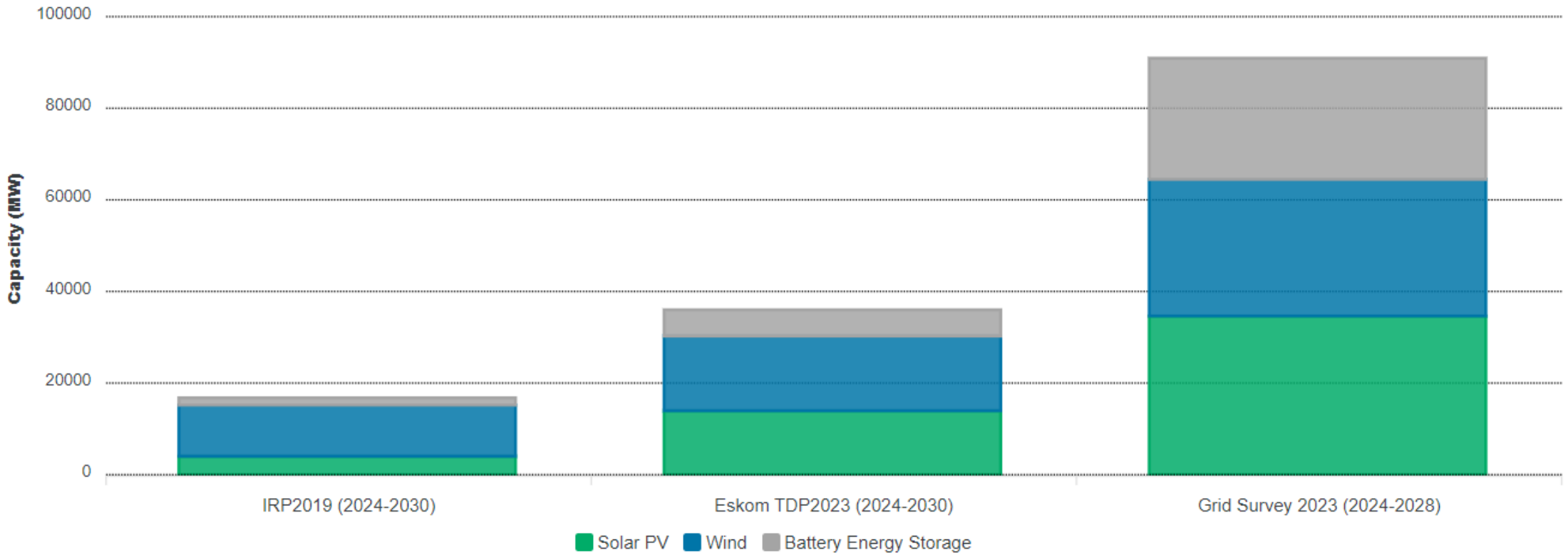
Large-scale renewable energy market size

Bid window	No. of projects	Total capacity	Progress
REIPPPP BW1	28	1 415 MW	All operational
REIPPPP BW2	19	1 033 MW	All operational
REIPPPP BW3	16	1 428 MW (excl. 17 MW cancelled)	16 operational 1 cancelled
REIPPPP BW3.5	2	200 MW	1 operational 1 under construction
REIPPPP BW4&4b	26	2 205 MW	25 operational 1 under construction
REIPPPP BW5	25	2 583 MW	9 under construction 16 awaiting commercial close
REIPPPP BW6	6	1 000 MW	Commercial close delayed
REIPPPP BW 7	Not known	5 000 MW	Announced in December 2023
RMIPPPP	5 (renewables only) out of 11	353 MW (renewables only)	2 operational 2 under construction 1 awaiting financial close
BESIPPPP BW1	4	513 MW	4 preferred bidders announced
TOTAL	131+	15 730 MW	

Projects registered with NERSA



Renewable energy capacity projections



SMART GRIDS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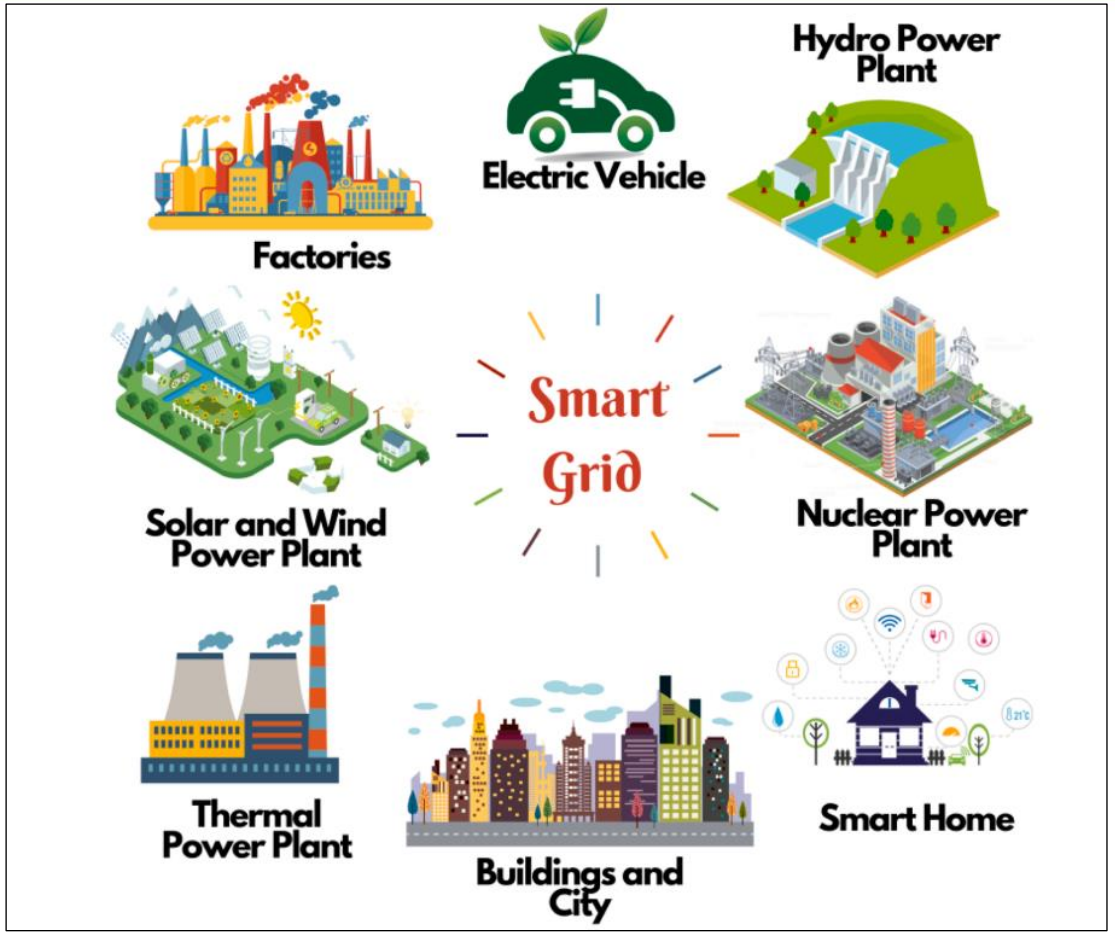
Smart Grids


Hydro Power Plant
Electric Vehicle
Factories
Smart Grid
Solar and Wind Power Plant
Nuclear Power Plant
Thermal Power Plant
Smart Home
Buildings and City

Overview of Smart Grid Technology

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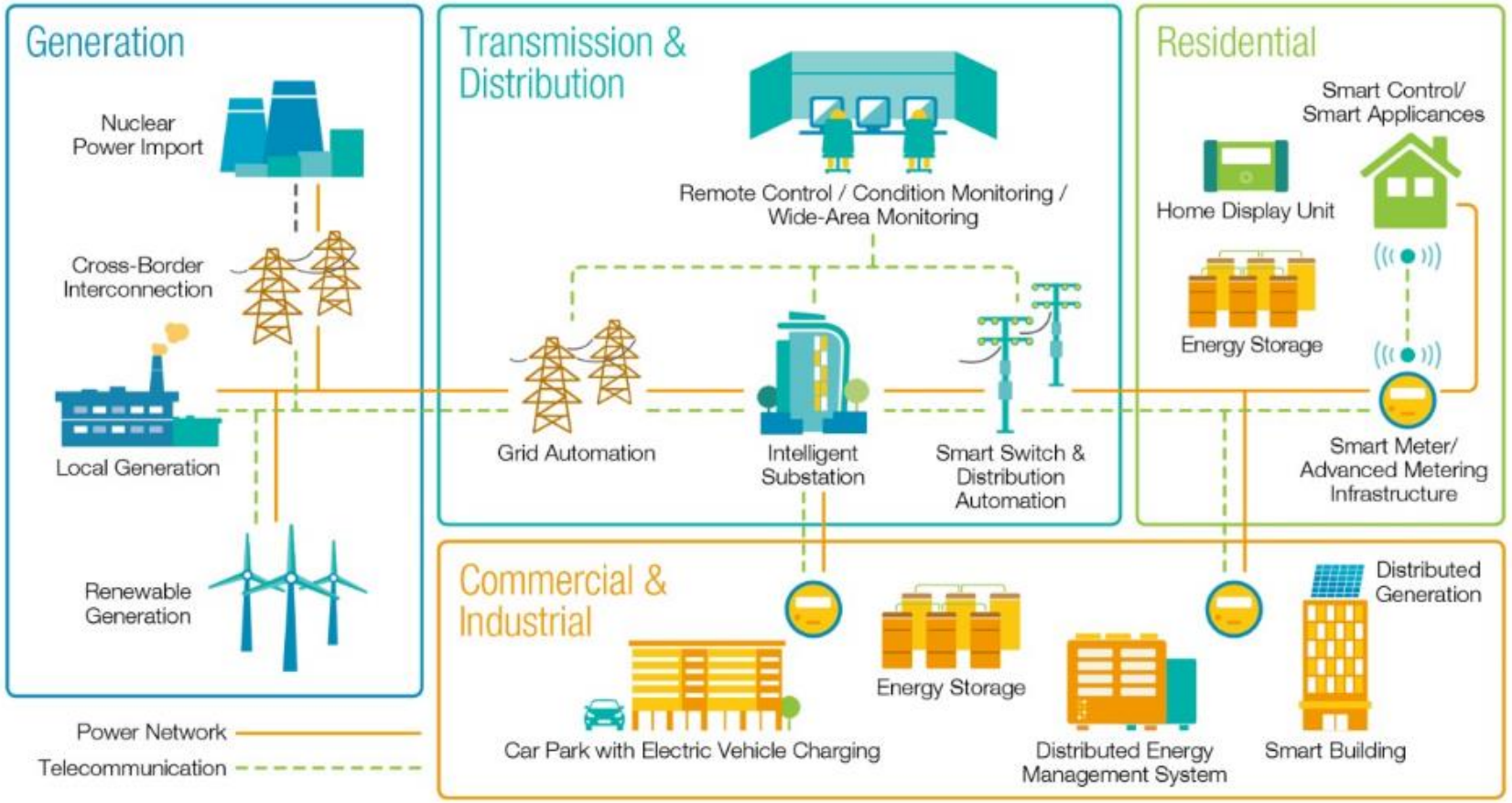
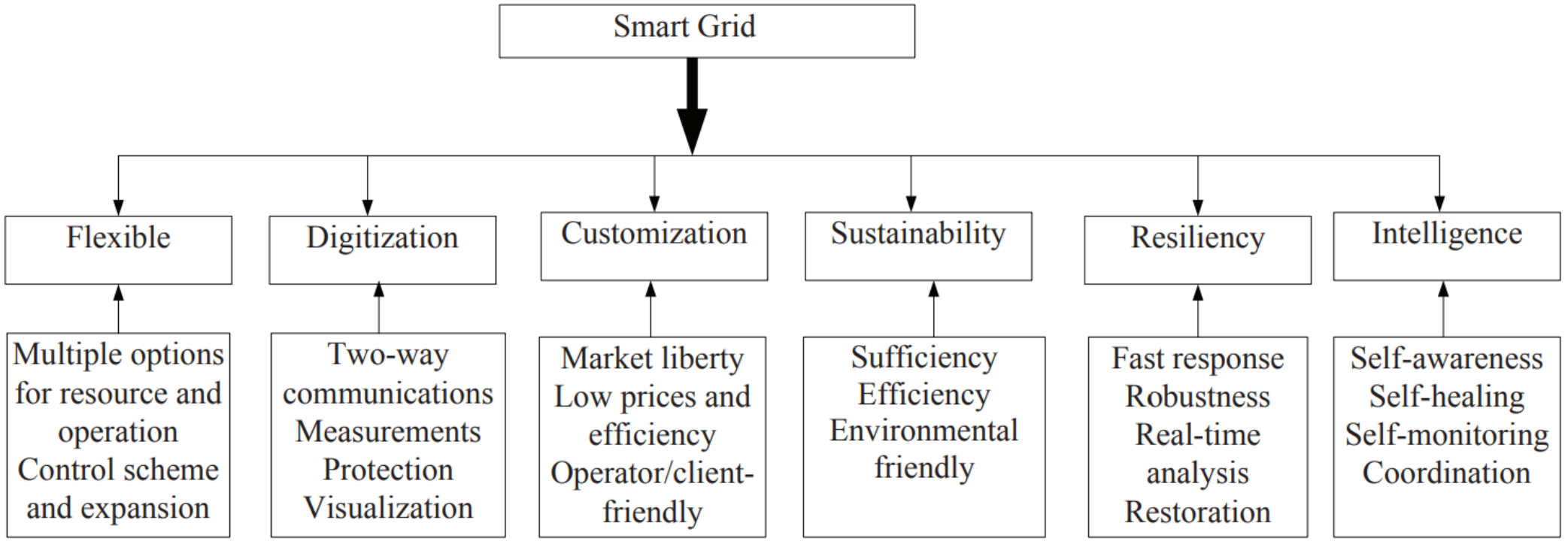
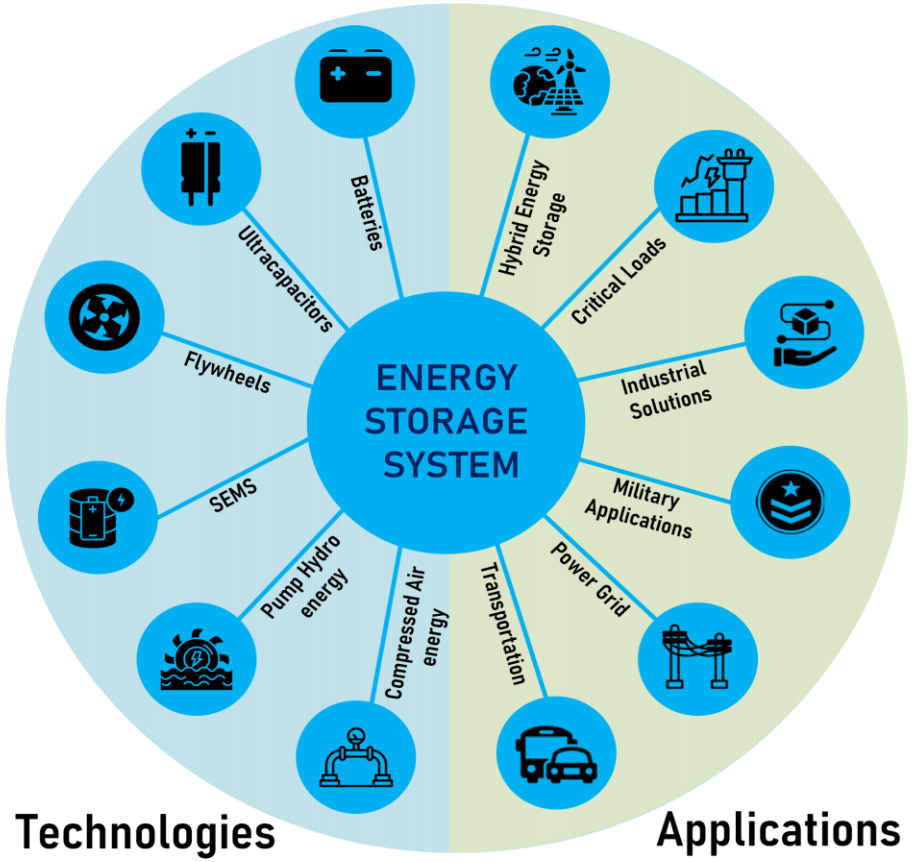


The main characteristics of a smart grid



INTEGRATION OF RE AND ESS IN SGs

Energy Storage Systems



Economic and Environmental Benefits

- **Enhanced Grid Stability and Reliability**
- **Efficient Integration of Renewable Energy**
- **Demand Response and Peak Shaving**
- **Enhanced Power Quality and Resilience**
- **Economic Advantages leading to cost savings by reducing operational costs and energy prices.**
- **Reduced carbon emissions**
- **Alignment with SDG 7 and SDG 13**

Challenges and Solutions

Challenge	Solution
Grid Stability and Reliability	- Advanced Forecasting: Implement advanced weather and output forecasting.
	- Flexible Generation: Use flexible generation sources to balance supply and demand.
	- Demand Response: Encourage consumers to adjust usage patterns in response to grid conditions.
Energy Storage Integration	- Battery Energy Storage Systems (BESS): Deploy advanced batteries to store excess energy.
	- Pumped Hydro Storage: Utilize existing or build new pumped hydro storage facilities.
	- Thermal Storage: Implement thermal storage systems.

Challenges and Solutions

Challenge	Solution
Grid Infrastructure	- Grid Modernization: Upgrade grid infrastructure for bi-directional energy flows and capacity.
	- Microgrids: Develop microgrids to enhance resilience.
	- Smart Inverters: Use smart inverters to manage power flows and maintain voltage stability.
Regulatory and Policy Issues	- Clear Policies: Develop clear, consistent policies supporting RE and ESS integration.
	- Incentives: Provide financial incentives for adopting RE and ESS technologies.
	- Standardization: Establish standards for grid interconnection and performance.

Challenges and Solutions

Challenge	Solution
Economic Viability	- Cost Reduction: Invest in R&D to lower costs of RE and ESS technologies.
	- Financial Mechanisms: Develop innovative financing mechanisms (e.g., PPAs, green bonds).
	- Market Structures: Create market structures rewarding flexibility and capacity services.
Cybersecurity	- Robust Cybersecurity Measures: Implement advanced cybersecurity measures.
	- Resilient Design: Design grid systems to be resilient against cyber-attacks.
	- Continuous Monitoring: Employ continuous monitoring and threat detection systems.

Challenges and Solutions

Challenge	Solution
Public Acceptance	- Education and Awareness: Conduct public education campaigns on RE and ESS benefits.
	- Community Engagement: Involve local communities in planning and decision-making.
	- Transparent Communication: Maintain transparent communication about project impacts and benefits.

Eskom Battery Energy Storage System (BESS) Project

The largest battery storage initiative in Africa, with a total capacity of 1,440 MWh and 360 MW of solar PV capacity.

Aims to stabilize the grid, reduce load shedding, and support renewable energy integration .

(Western Cape)

Jeffreys Bay Wind Farm

One of the largest wind farms in South Africa, contributing significantly to the renewable energy mix.

Demonstrates successful integration of wind energy into the national grid.

138MW Wind Farm (Eastern Cape)

Ekurhuleni Municipality Microgrid

Approval of a large solar PV plant and lithium-ion battery system, forming one of South Africa's largest microgrids.

Enhances grid stability and reliability by integrating renewable energy and storage.

1.8 MW solar PV facility alongside a 2.9 MWh battery, while being grid-connected to stabilise the local grid. (PepsiCo- Gauteng)

Redstone Solar Thermal Power Project

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A concentrated solar power (CSP) project utilizing molten salt for thermal energy storage.

Provides reliable and dispatchable solar power, enhancing grid stability.

100MW, 12-hour storage supplying approx. 200 000 households (Northern Cape)

Conclusion

- **Key Takeaways**
  - Addressed challenges in integrating RE and ESS into SGs
  - Presented solutions for grid stability, reliability, and efficiency
- **Benefits of Integration**
  - Economic and environmental advantages
  - Enhanced grid performance and sustainability
- **Future Outlook**
  - Continuous technological advancements
  - Supportive policies and regulatory frameworks
- **Call to Action**
  - Encourage stakeholders to embrace innovative solutions
  - Foster collaboration among energy professionals, policymakers, and researchers
- **Final Thought**
  - By effectively integrating renewable energy and energy storage systems into smart grids, we can achieve a sustainable, reliable, and resilient energy future.

THANK YOU !

Questions ?