SUPPORTING THE SOUTH AFRICAN GRID: GEOSPATIAL CAPACITY ALLOCATION AND INTEGRATION OF RE GENERATION

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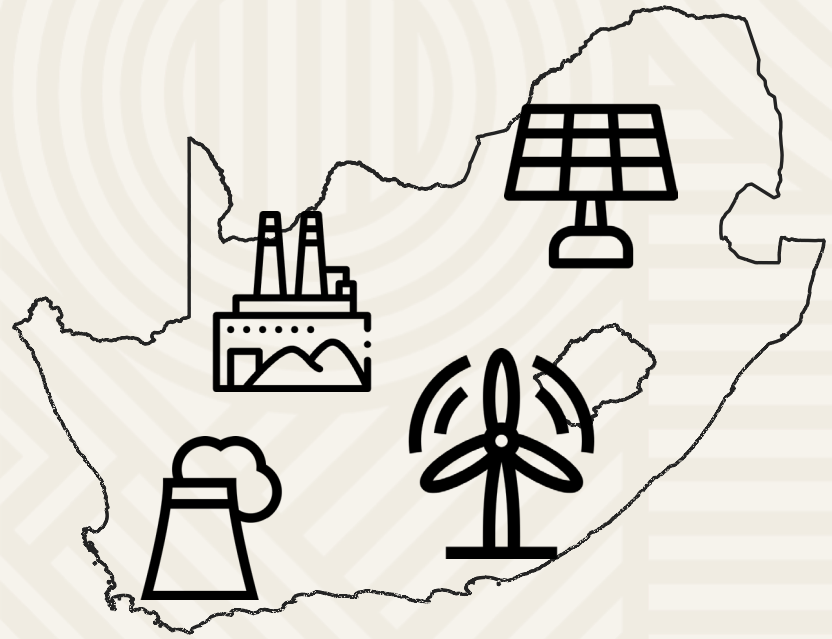
Photo by Stefan Els

SOUTH AFRICA'S CURRENT RENEWABLE ENERGY STATUS



- Nominal energy capacity (Dec 2022): 54.6 GW
- Coal — 39.8 GW
- Nuclear — 1.9 GW
- Diesel (OCGT) — 3.4 GW
- Hydro — 0.6 GW and Pumped storage — 2.7 GW
- Wind — 3.4 GW
- Solar PV — 2.3 GW
- CSP — 0.5 GW

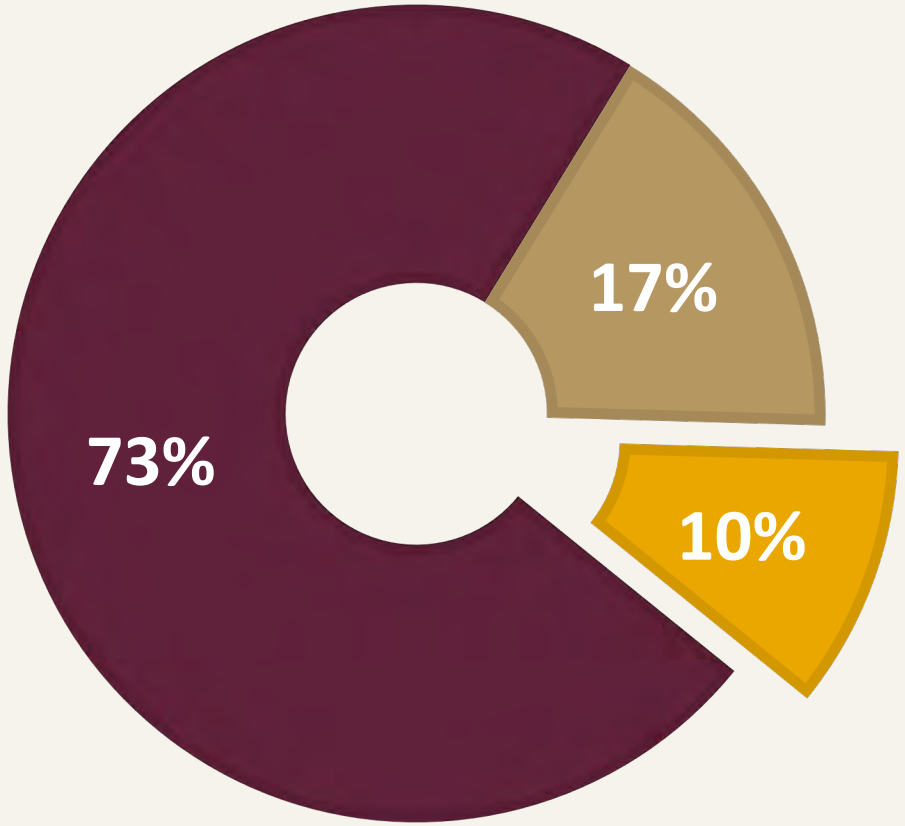
17 % RE capacity to 83 % thermal capacity

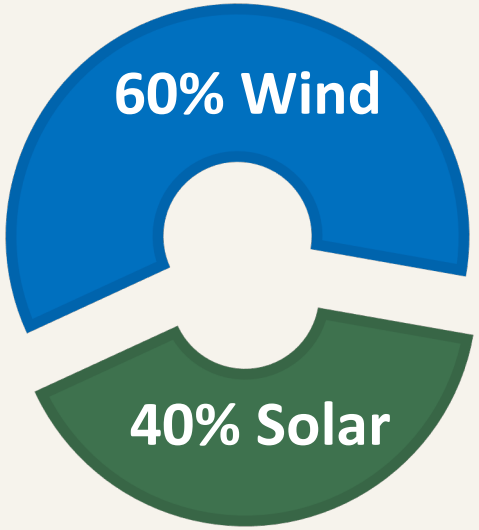
SOUTH AFRICA'S CURRENT RENEWABLE ENERGY STATUS

Coal **73%**

Wind and Solar PV **10%**

Other **17%**





SOUTH AFRICA'S PLANNED RENEWABLE ENERGY FUTURE

2030	Coal	Nuclear	Hydro	Storage	PV	Wind	CSP	Gas & Diesel
TIC	33364	1860	4600	5000	8288	17742	600	6380
TIC (%)	43	2.36	5.84	6.35	10.52	22.53	0.76	8.10
AEC (% of MWh)	58.80	4.50	8.40	1.2*	6.30	17.80	0.60	1.30
TIC	Total Installed Capacity							
AEC	Annual Energy Contribution							

SOUTH AFRICA'S PLANNED RENEWABLE ENERGY FUTURE

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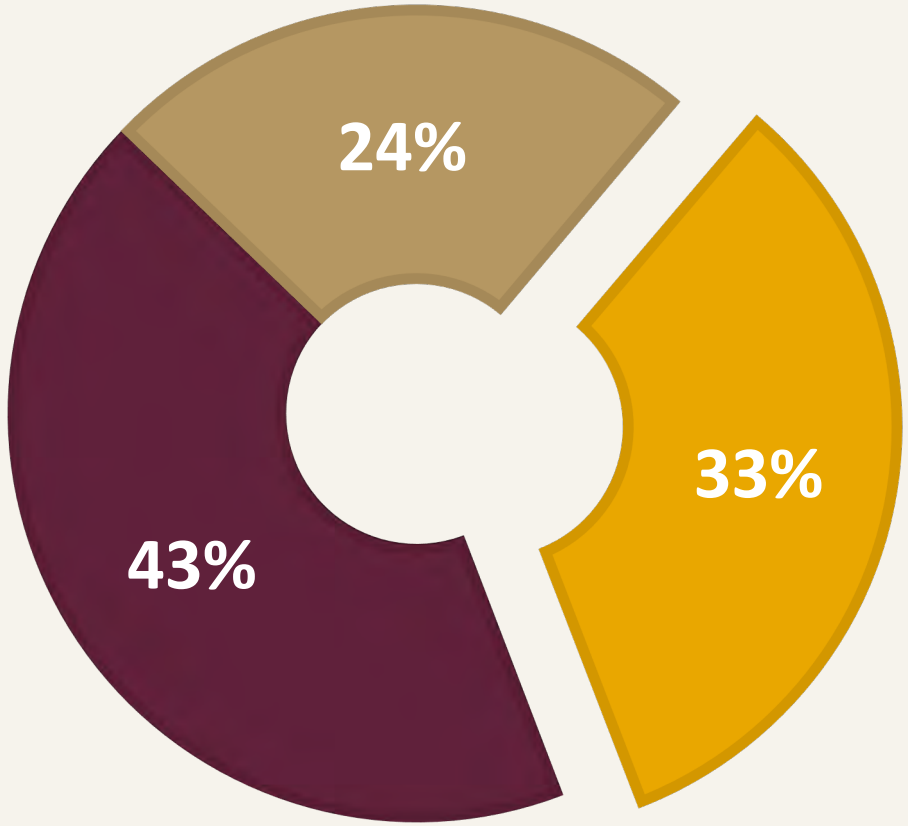
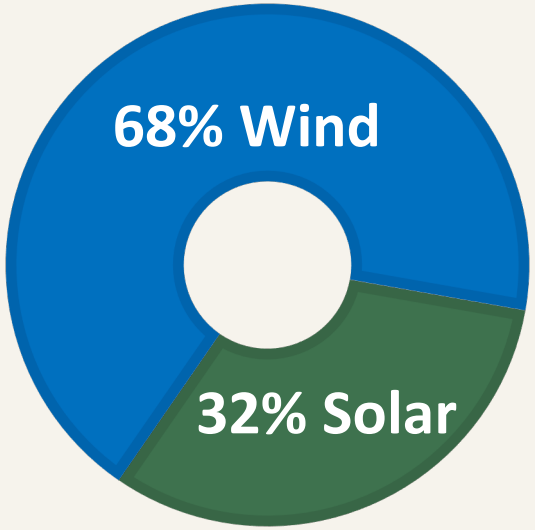
Coal **43%**

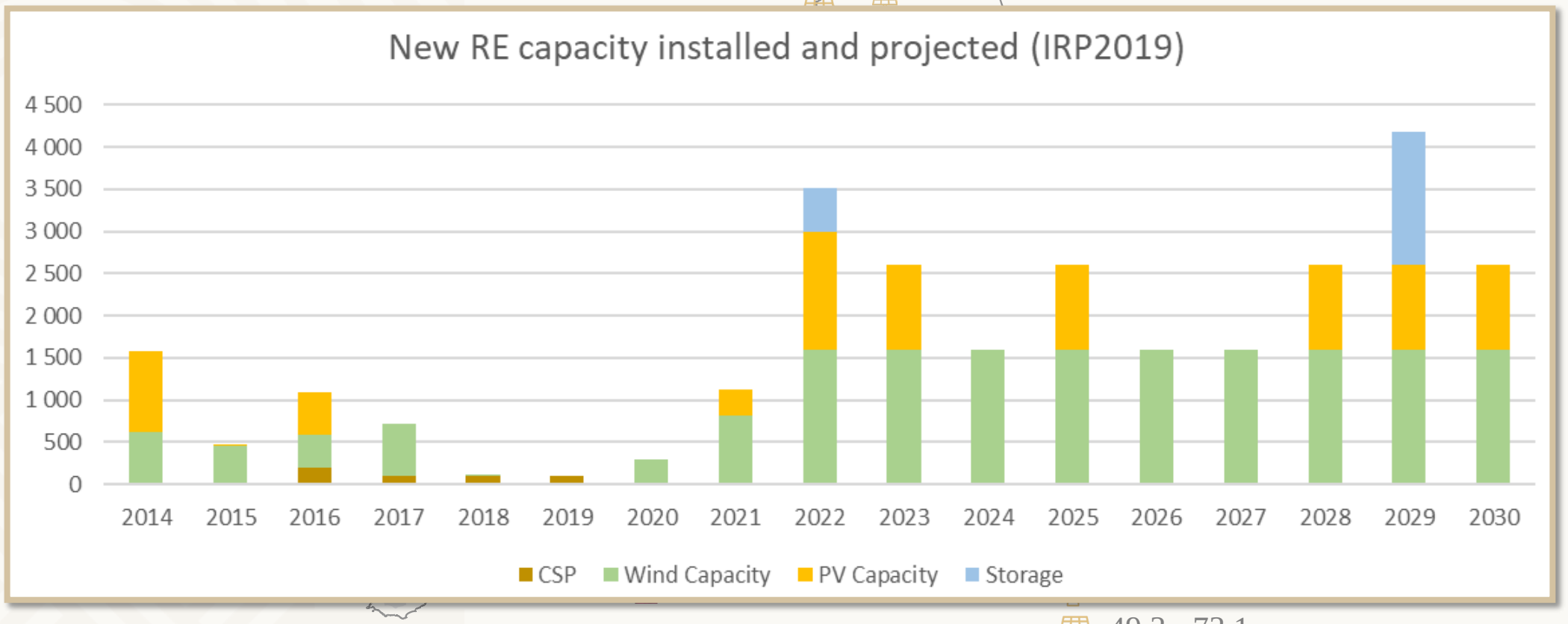
Wind and Solar PV **33%**

Other **24%**





SOUTH AFRICAS ENERGY INFRASTRUCTURE

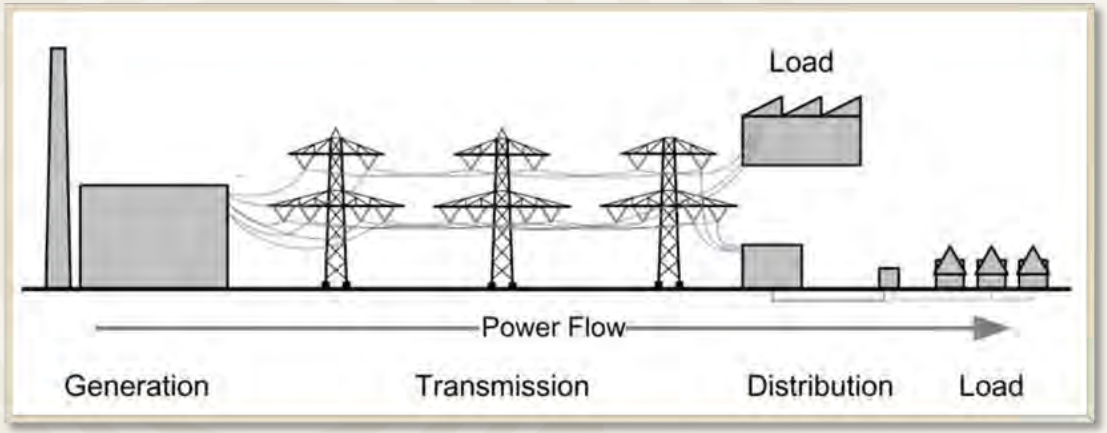


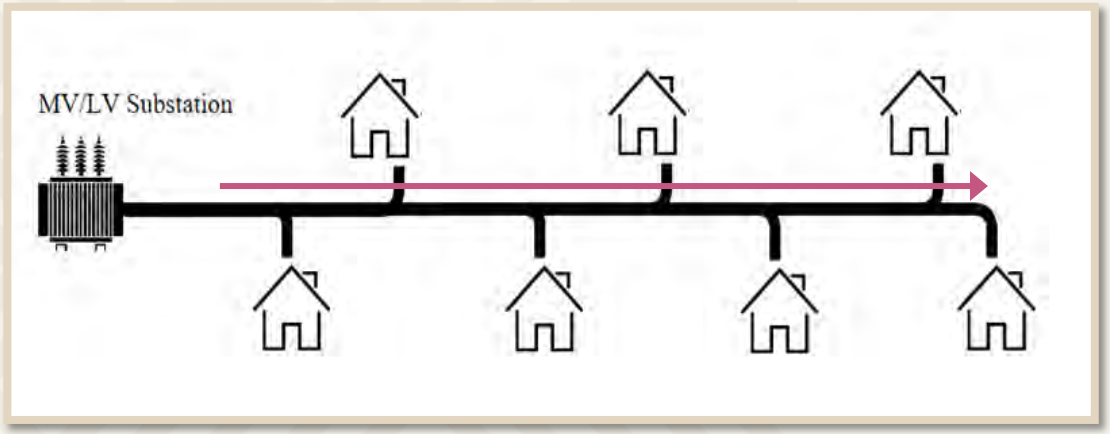
49.3 - 73.1

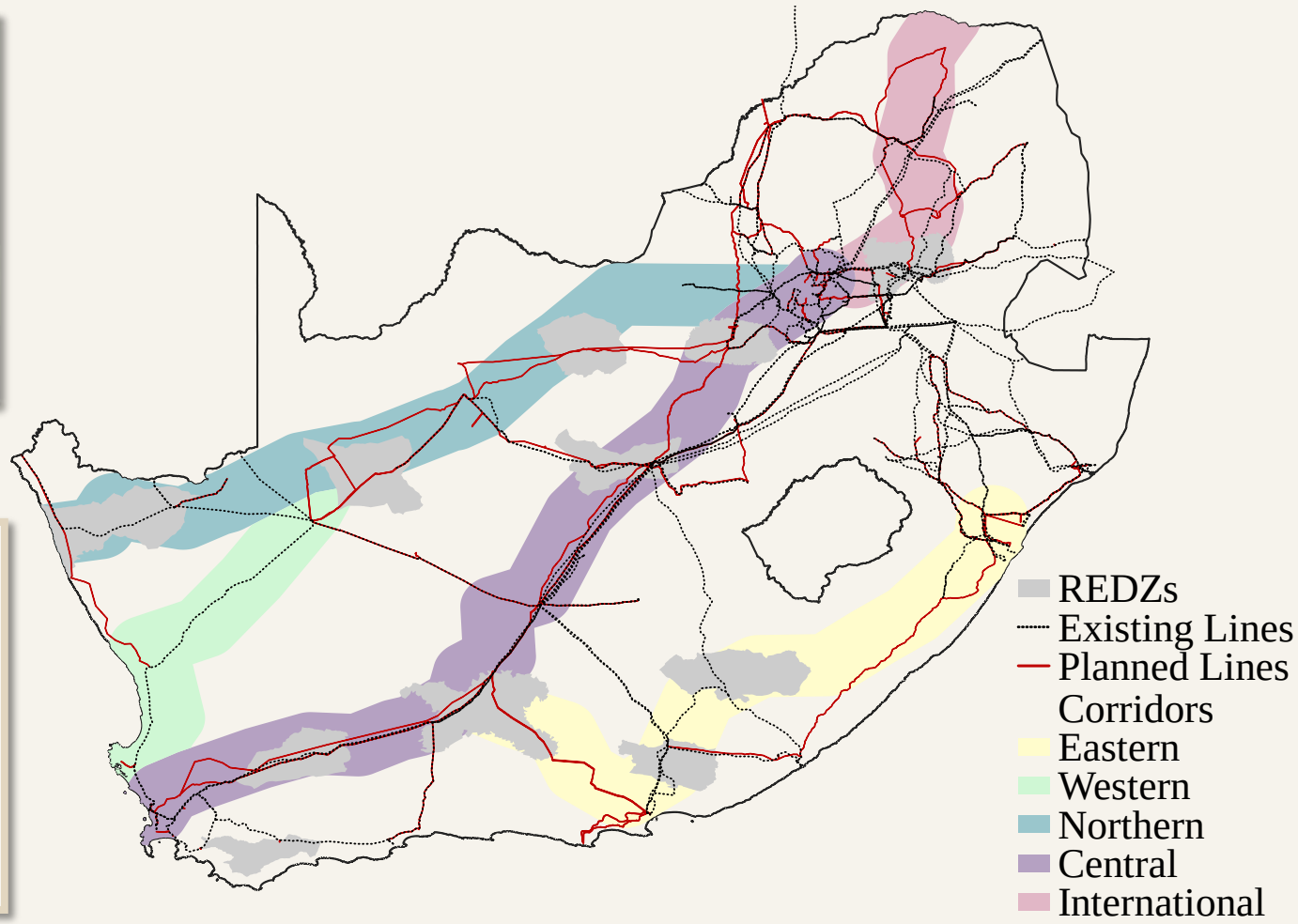
73.1 - 75

75

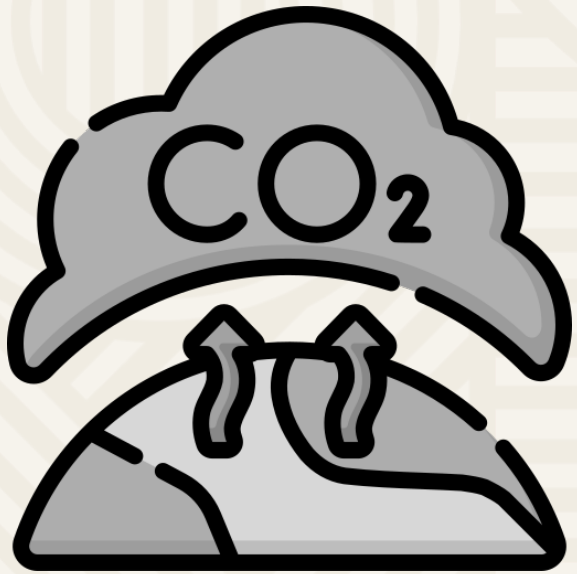
WHAT IS THE TRADITIONAL POWER SYSTEM?

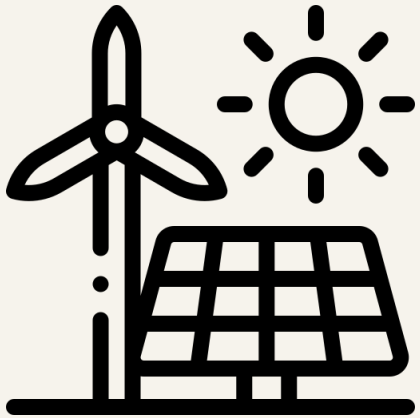


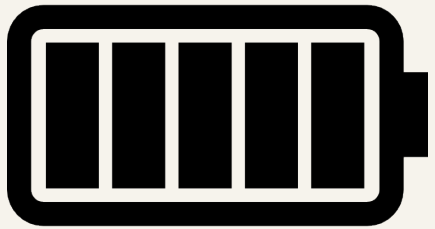




WHERE ARE WE HEADED?
WHY SHOULD WE ADAPT?







FLEXIBILITY IS KEY

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Flexible Generation: Flexible units (CCGT, Hydro, etc.), Variable Renewable Energy (VRE) curtailment, geospatial dispersion of VRE

Flexible Load Demand: Demand response, electric vehicles, power to gas/heat

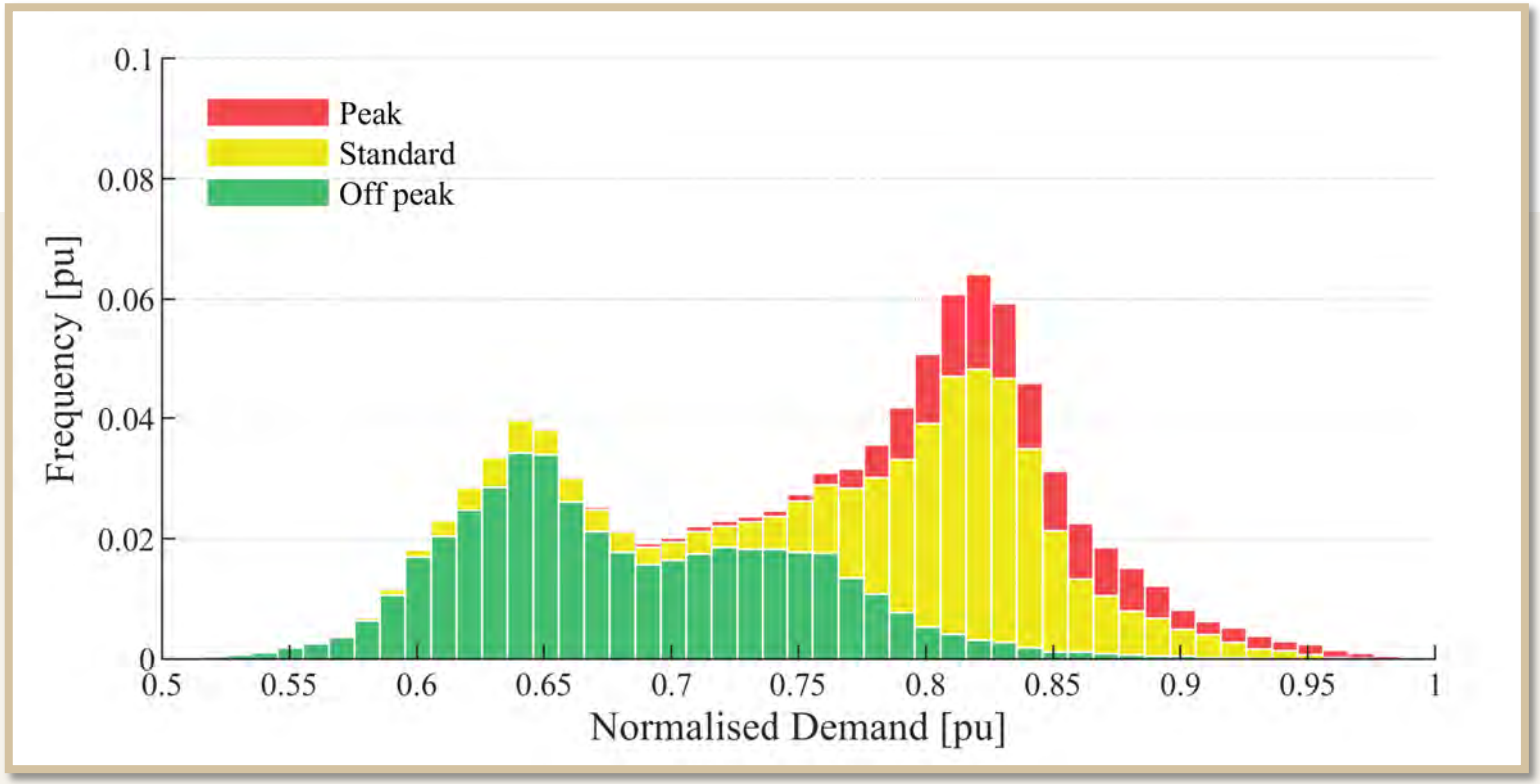
Energy Storage: Batteries, hydrogen, pumped hydro

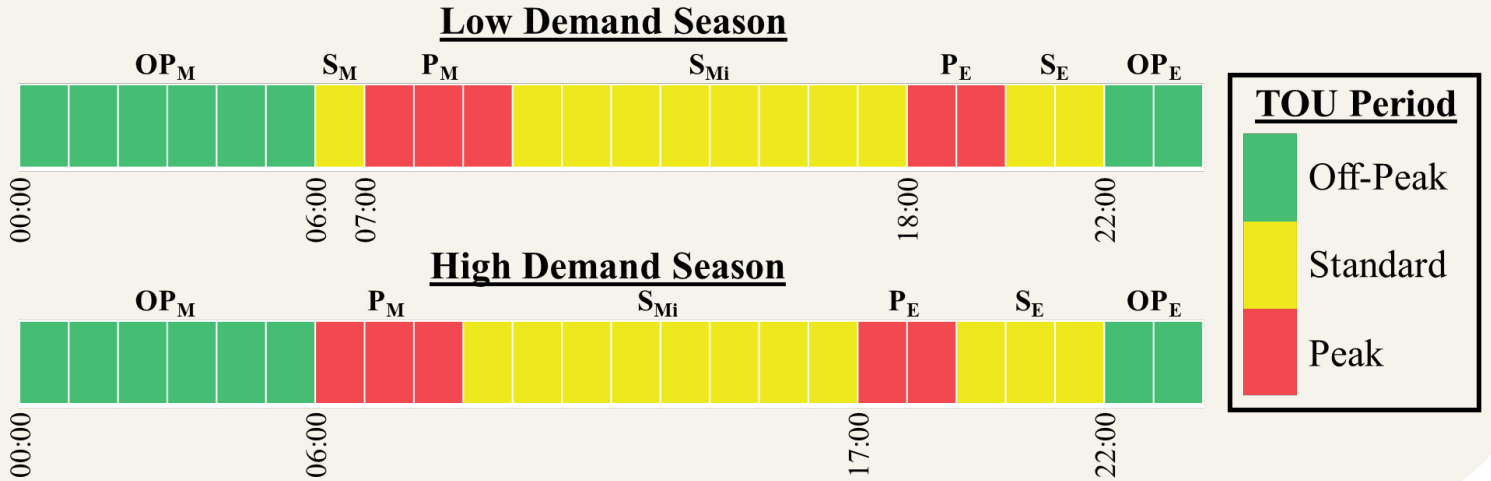
Grid Infrastructure: Transmission level expansion, strengthen distribution

Improved Operations: Improved initial and continuous planning, improved VRE forecasting, increased balancing, dynamic energy market design

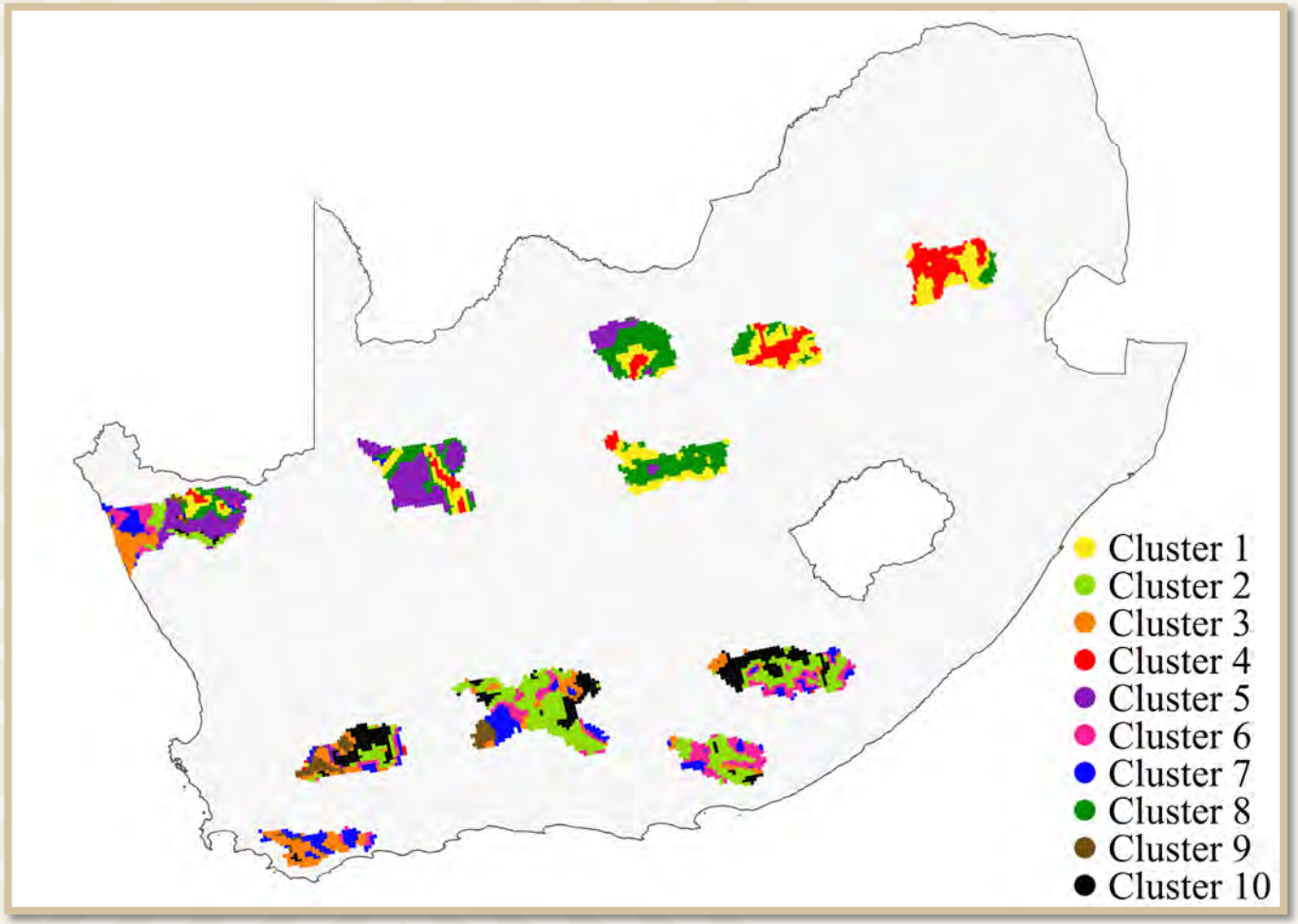
GEOSPATIAL CAPACITY ALLOCATION

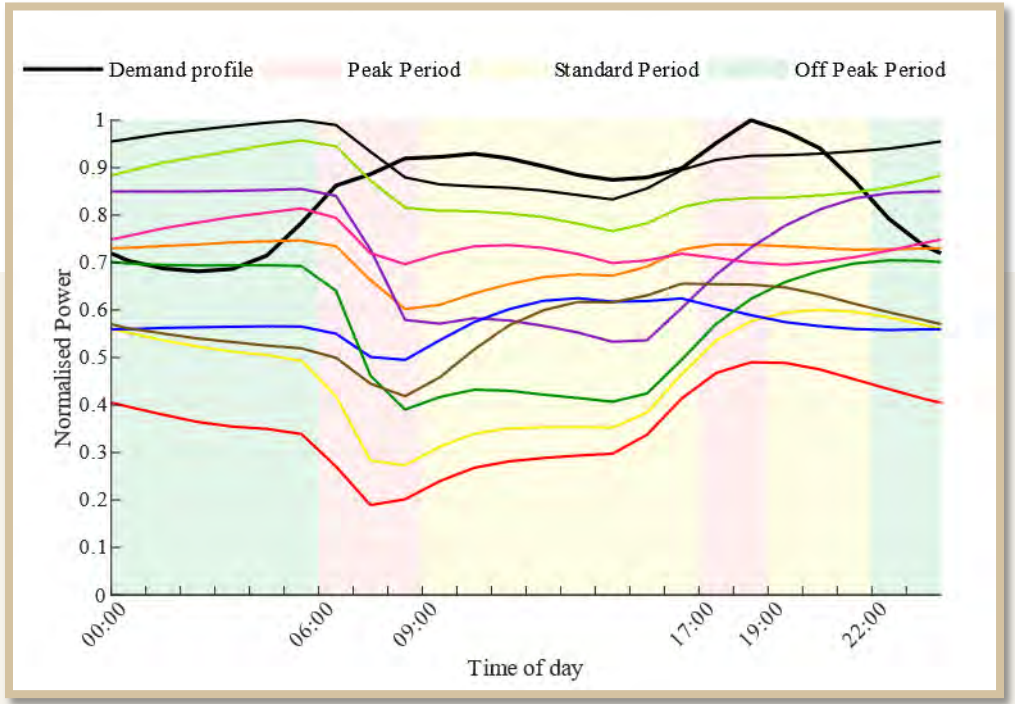
Fixed bulk-supply ToU tariff structure for large consumers and resellers which are connected at the transmission level

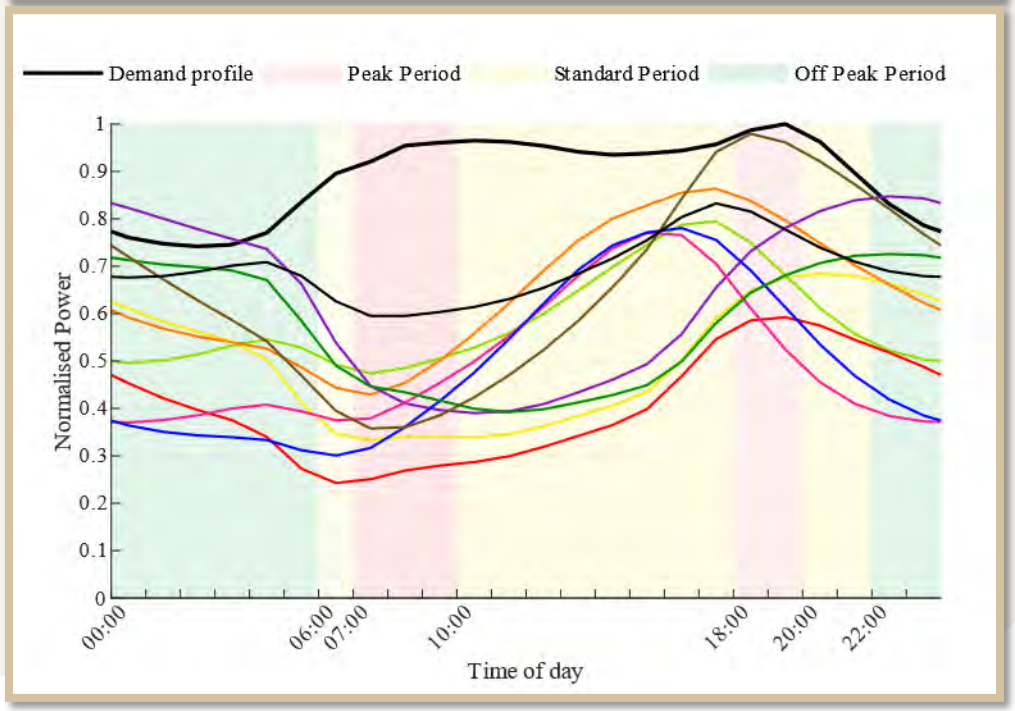




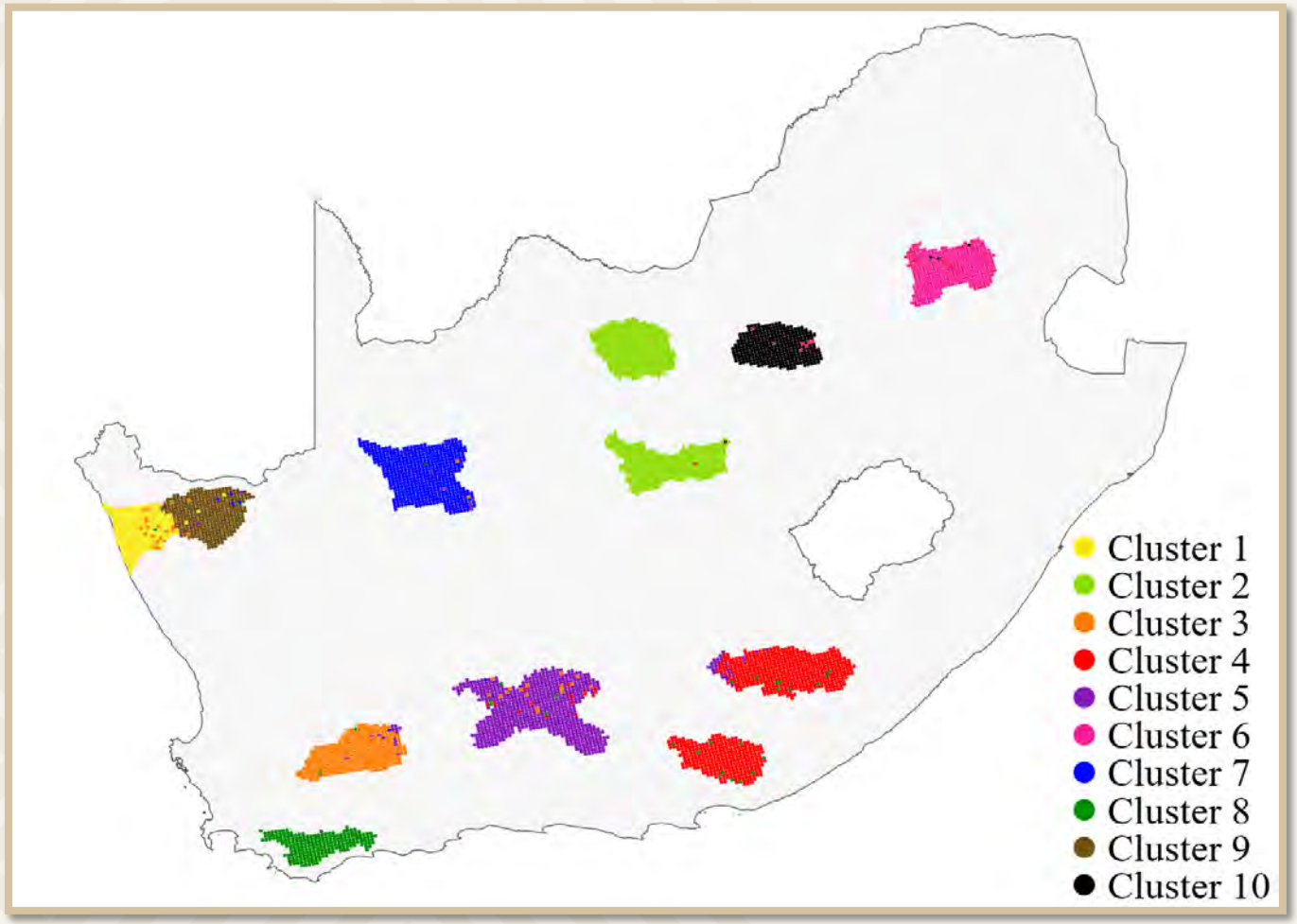
CLASSIFICATION OF WIND RESOURCES

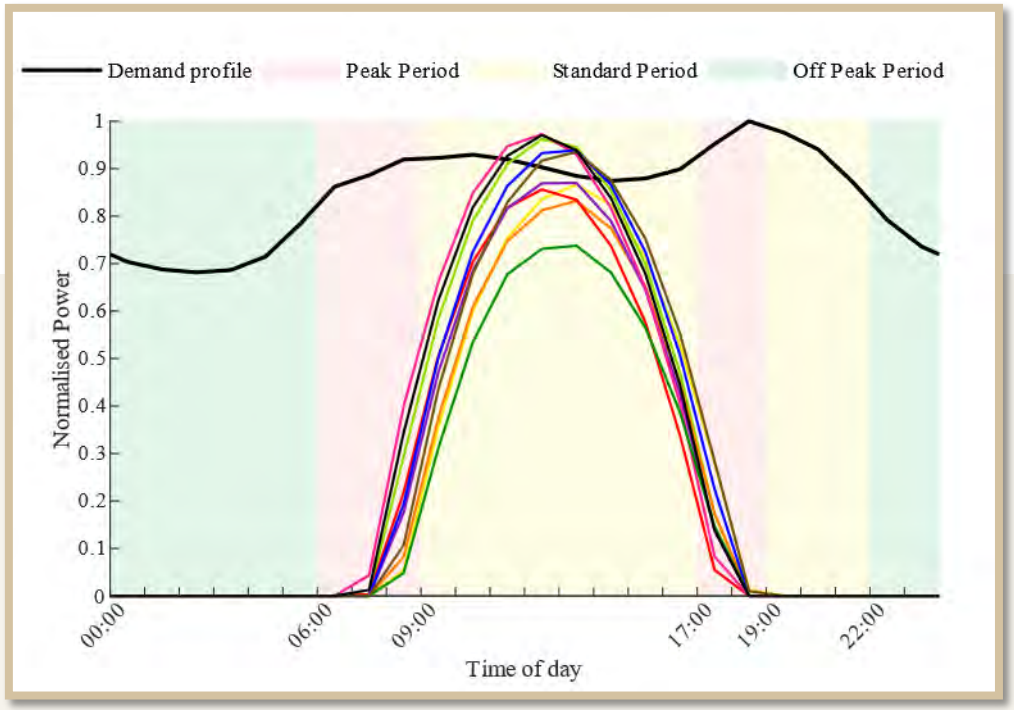


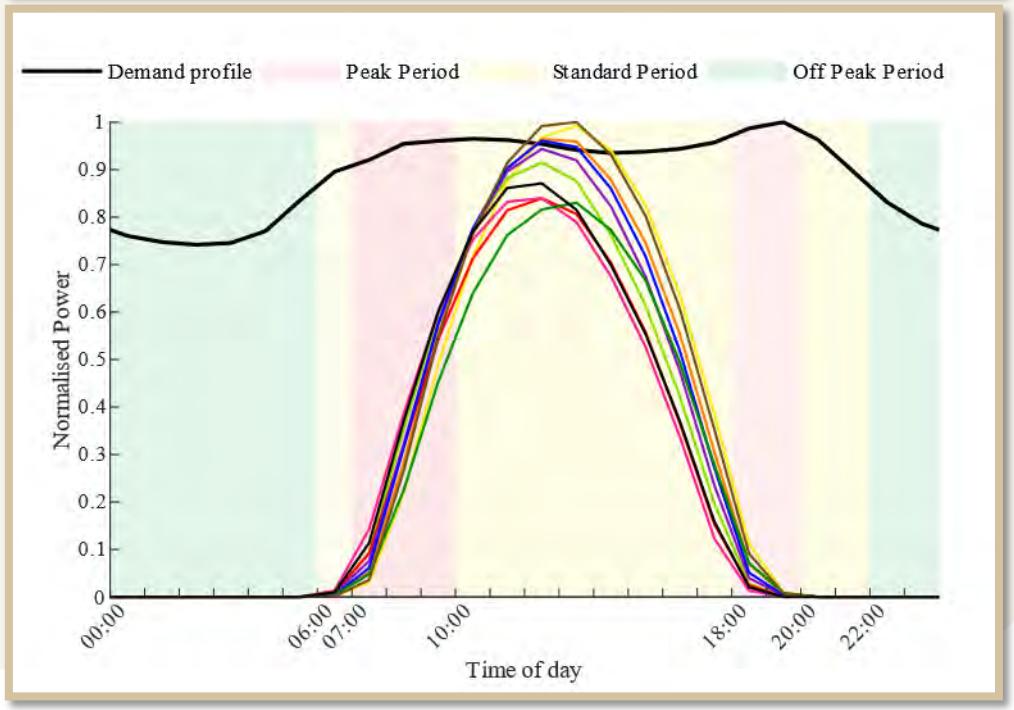




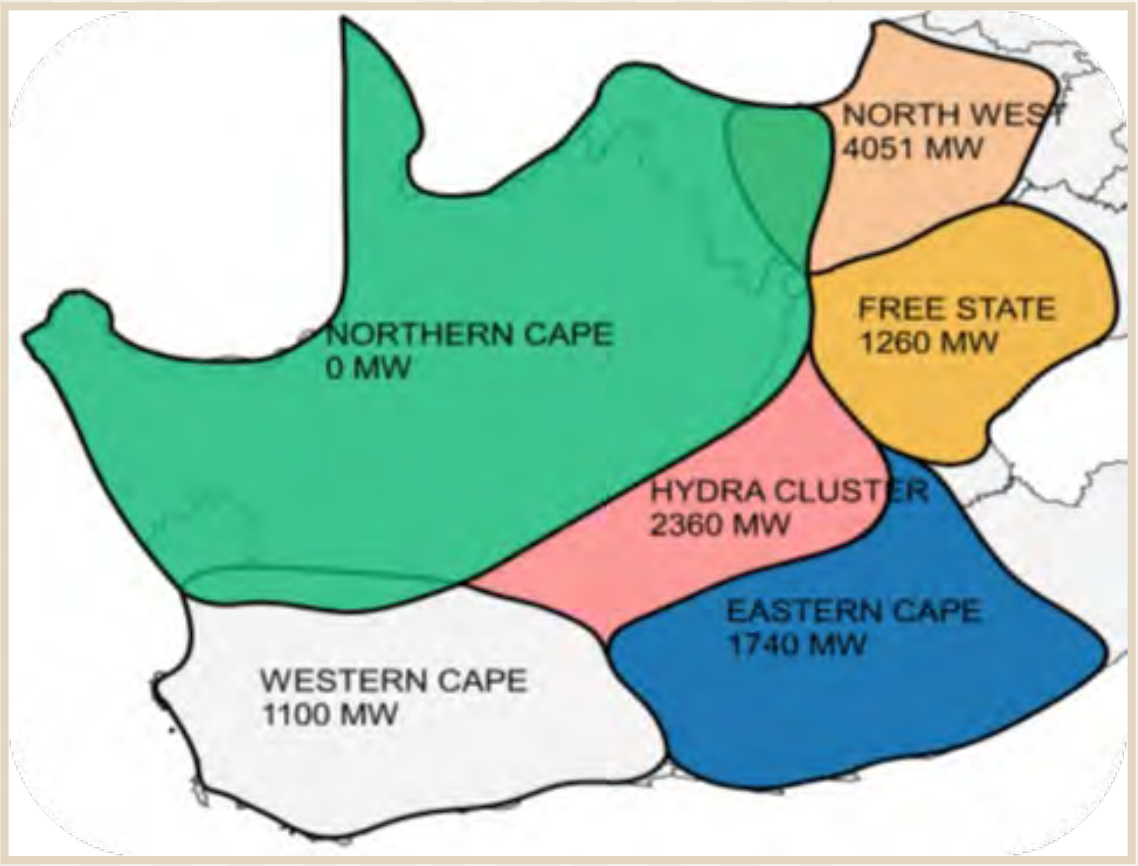
CLASSIFICATION OF SOLAR RESOURCES

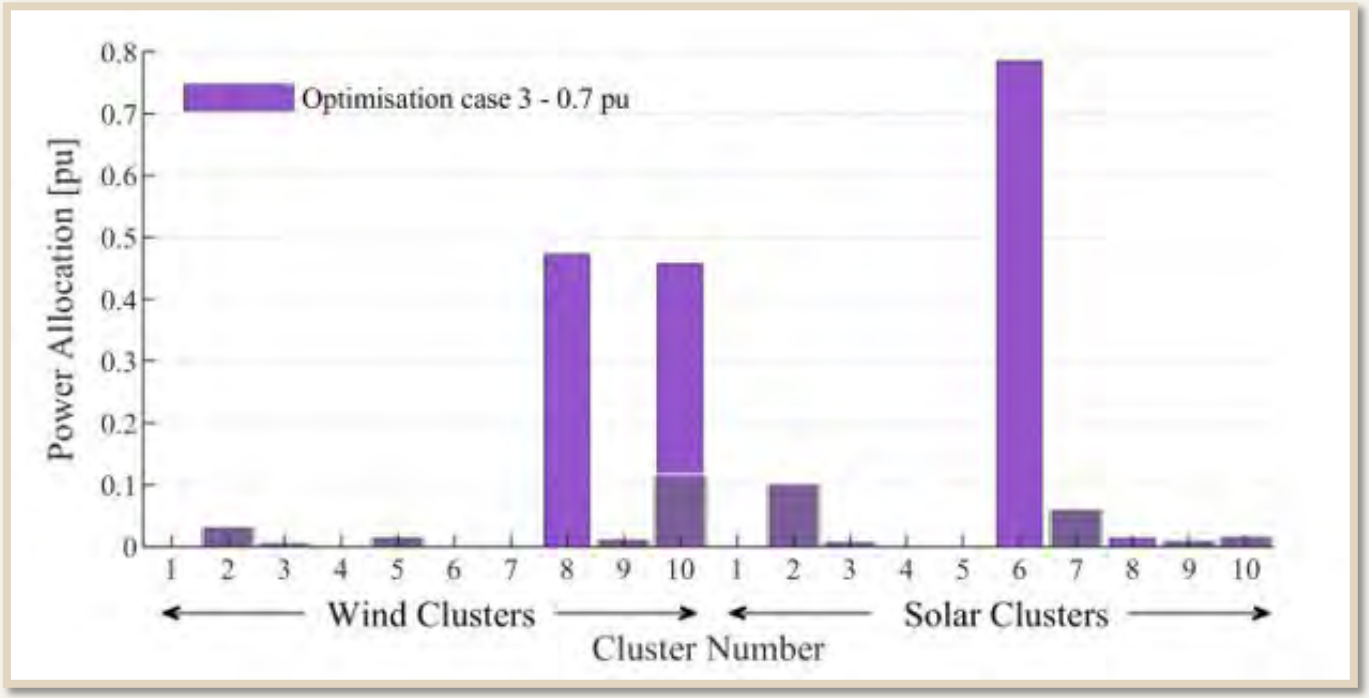






OPTIMAL ALLOCATION OF VARIABLE RENEWABLE RESOURCES





THE IMPACT OF CLIMATE CHANGE ON RENEWABLE RESOURCES

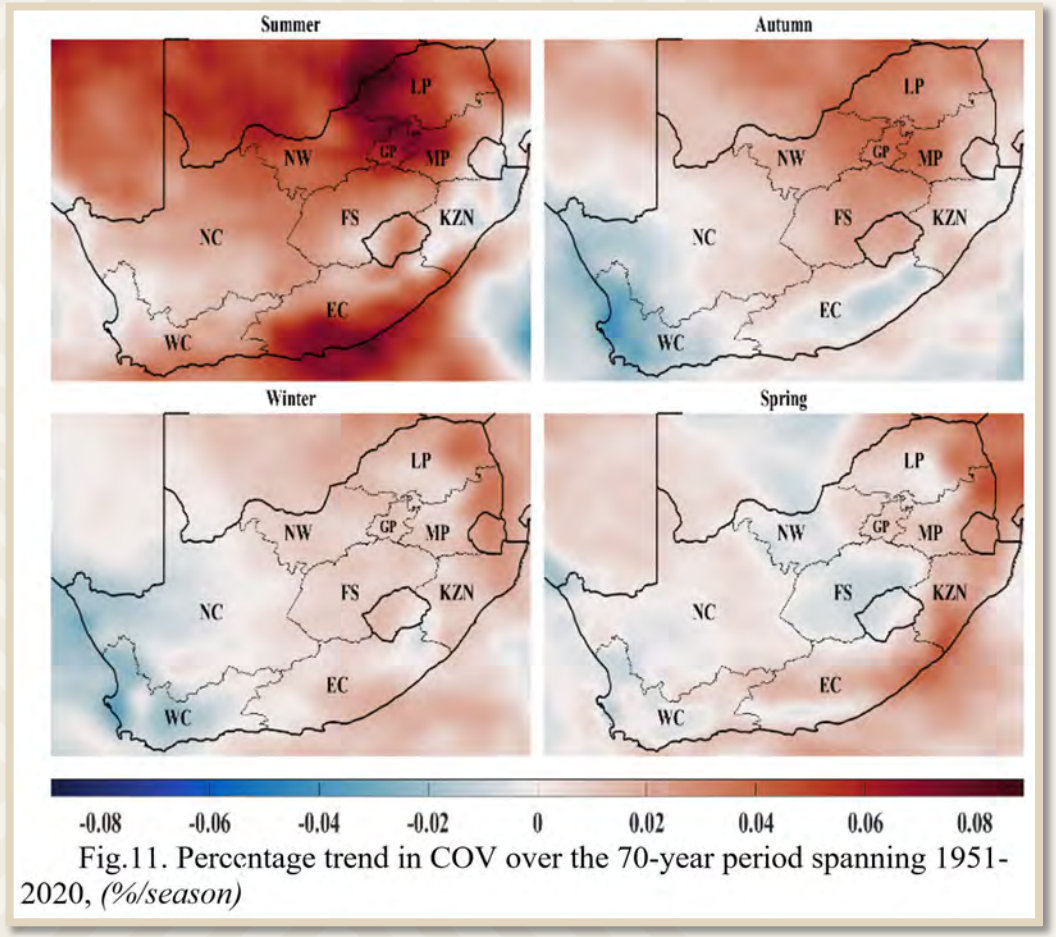
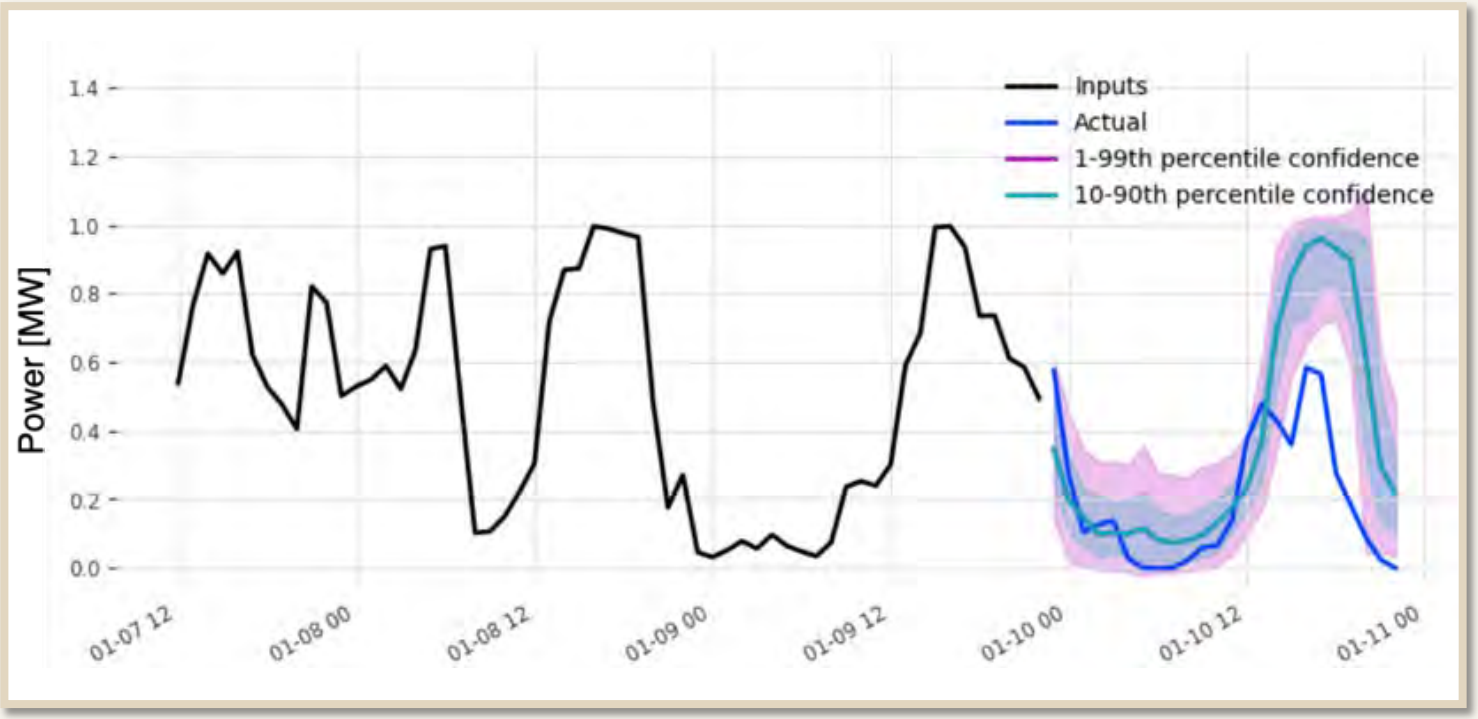


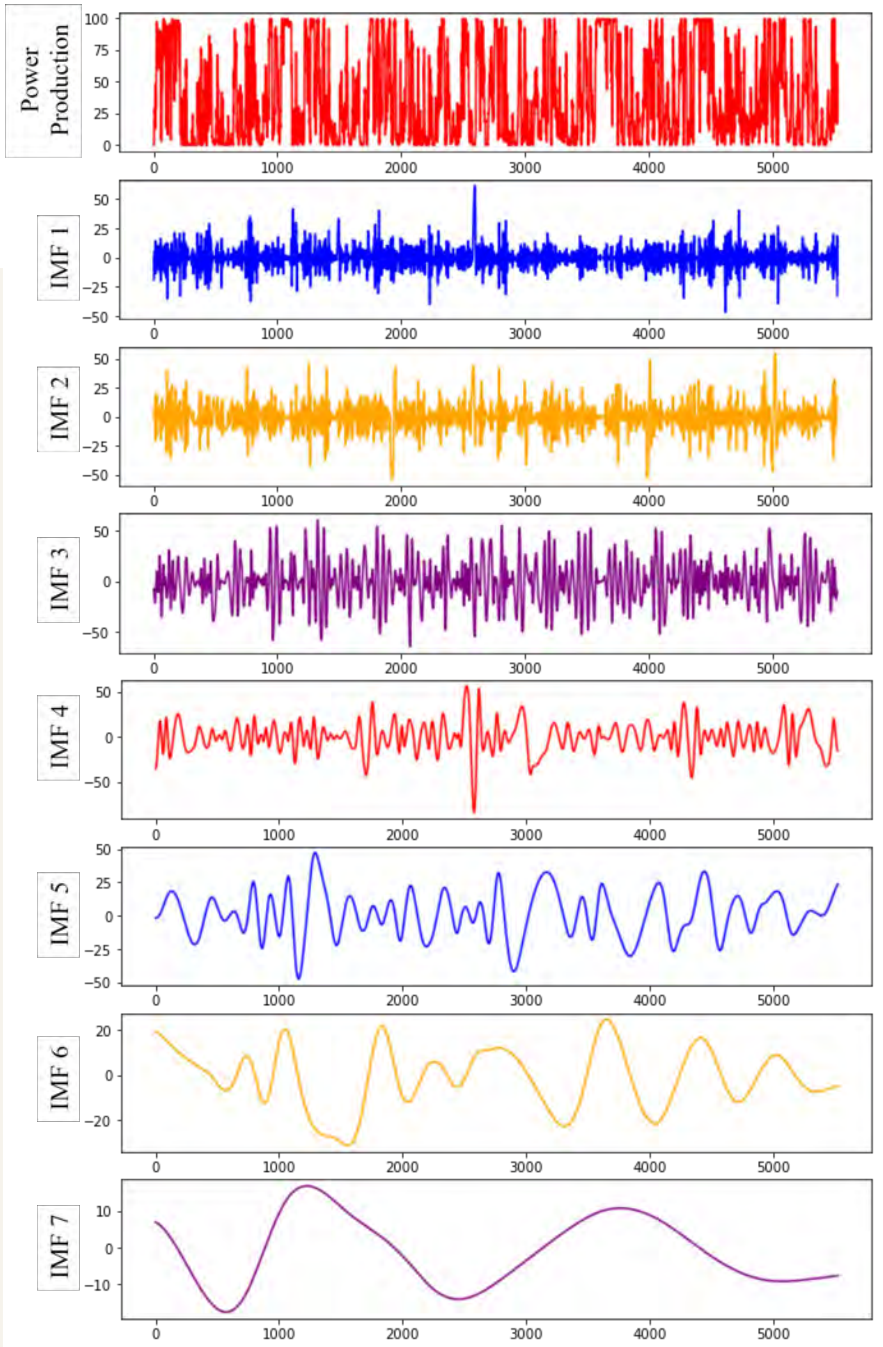
Fig.11. Percentage trend in COV over the 70-year period spanning 1951-2020, *(%/season)*

- Looking at the VRE capacity and variability of South Africa historically
- What is the predicted impact in the future?

FORECASTING OF WIND GENERATION

Using Hybrid Recurrent Neural Networks with Empirical Mode Decomposition and Temporal Fusion Transformer



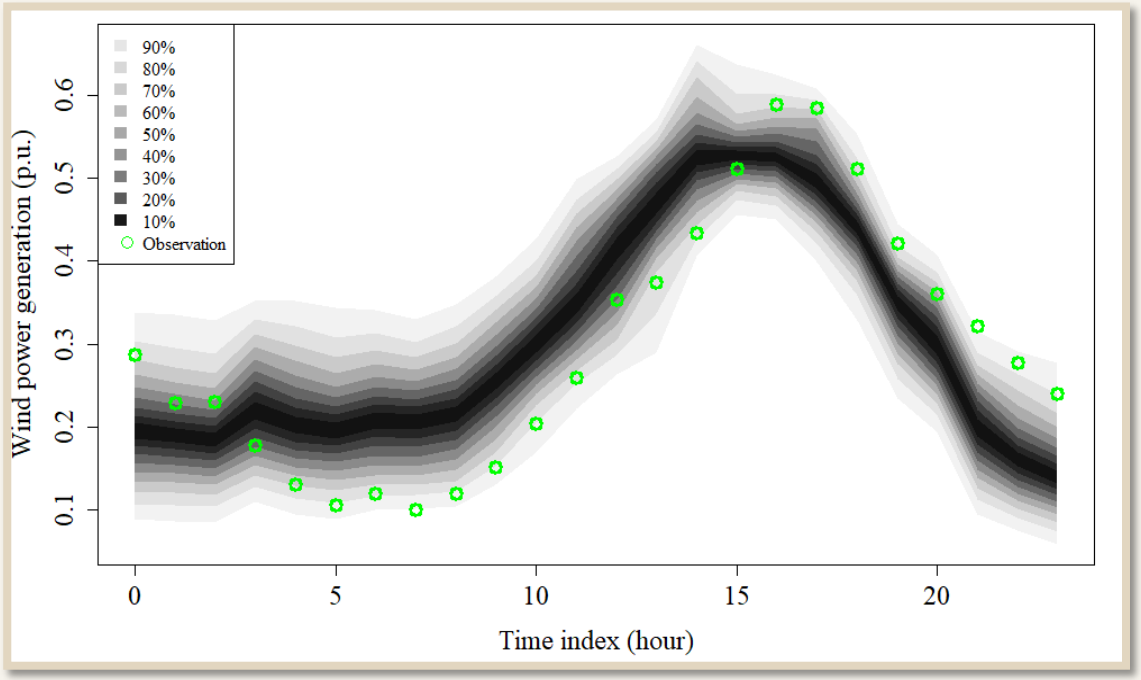


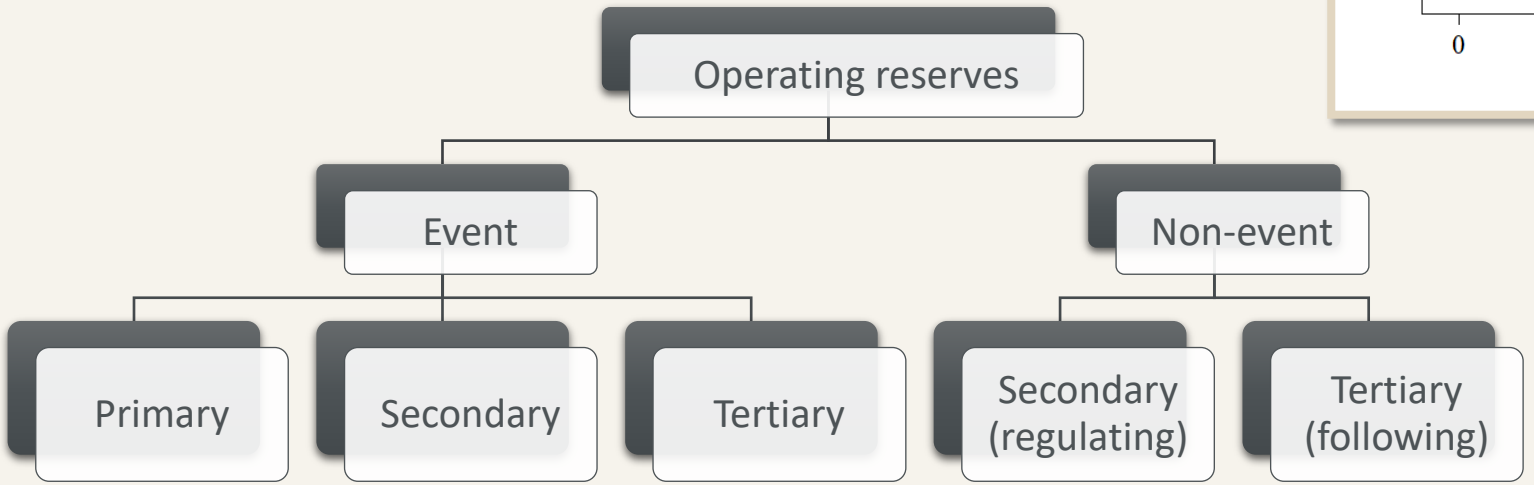
Time Series Sequence

POWER SYSTEM OPERATIONS

Improving:

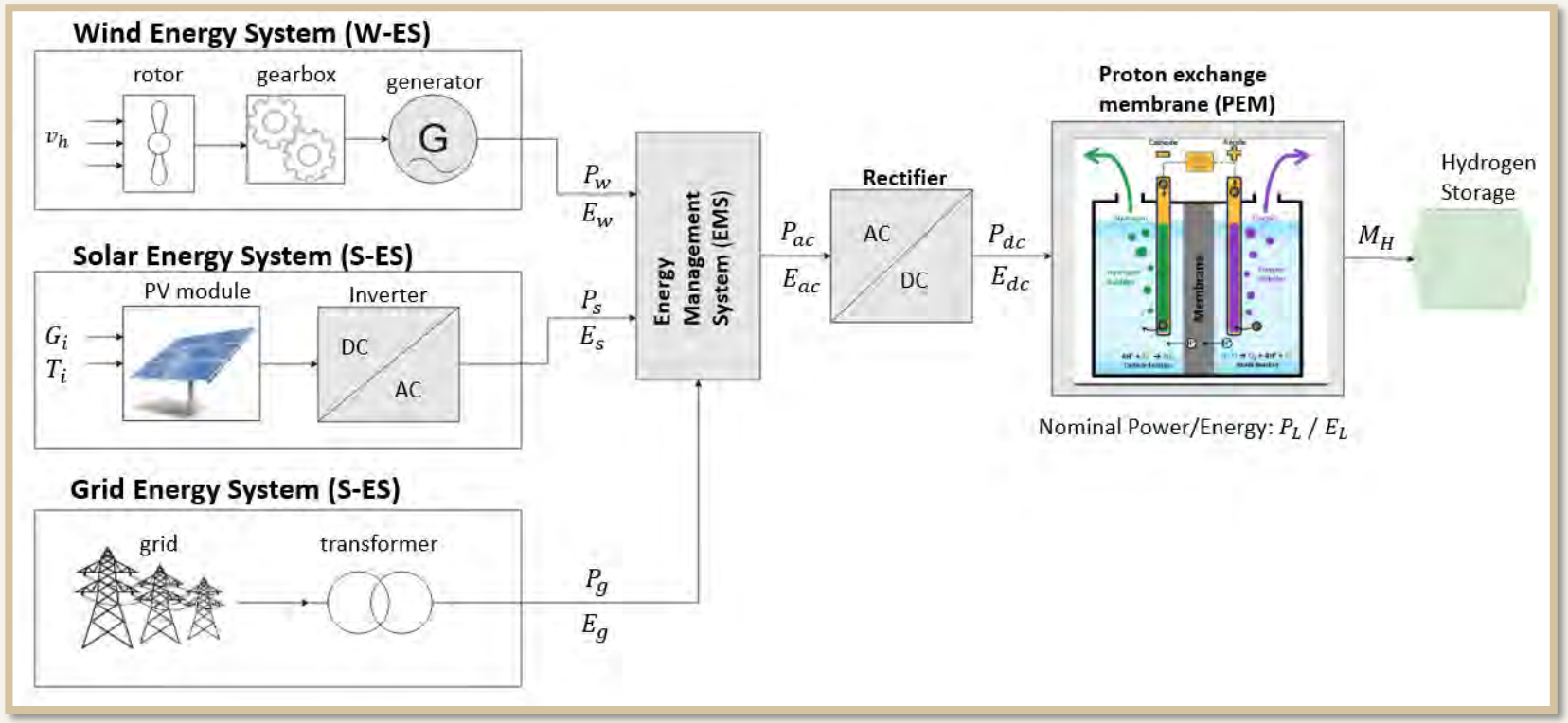
- Unit commitment
- Scheduling
- Reserve allocation methodologies





DIVERSIFY ENERGY-MIX FOR GREEN HYDROGEN PRODUCTION

- Maximize reliability of the energy system
- Minimize cost of electricity usage for hydrogen production
- Maximize efficiency of the energy system



With the use of modelling and optimization techniques

OPTIMIZING ELECTRICAL INFRASTRUCTURE FOR GREEN HYDROGEN PRODUCTION UNITS IN SA

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- Determining ideal locations for green hydrogen plants
- Development of a framework to aid in informed decision-making pertaining to local and international green hydrogen investment.

Key study areas

- Logistics around the transportation of green hydrogen
- Cost, efficiency, and safety analysis for the entire value chain

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