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SAWEA
South African Wind Energy Association

21 - 23 OCTOBER 2025
8:00 am – 5:00 pm

CAPE TOWN, SA
CTICC 2

2025 PRESENTATION

Optimised Geospatial Model for Strategic Renewable Energy Deployment

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23 October 2025

SPEAKER **OVERVIEW**

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PRESENTATION **OVERVIEW**

01 Methodology

02 Input assumptions and definitions

03 Results

04 Other Applications

Introduction

Purpose:

Develop a geospatial framework to evaluate renewable energy potential and guide future planning.

Key Goals:

- Quantify wind and solar availability using validated, high-resolution datasets.
- Identify zones with strong and consistent renewable resources.
- Integrate environmental and infrastructural constraints for realistic site suitability.
- Align renewable resource availability with daily and seasonal demand patterns.
- Enable data-driven decision-making for long-term energy planning.

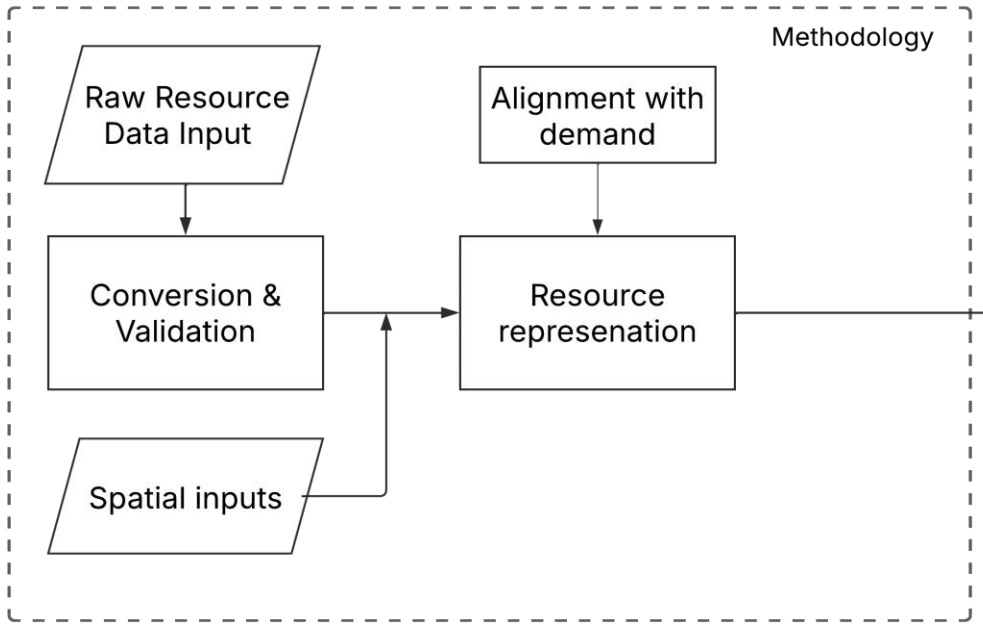
Considerations:

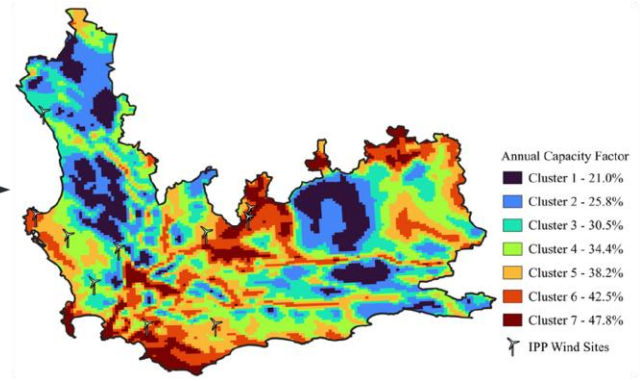
- Temporal variability and complementarity of wind and solar generation.
- Influence of terrain, exclusion zones, and protected landscapes.
- Connection proximity to existing infrastructure.
- Uncertainty from model resolution and interannual climate variations.
- Flexibility for application across multiple regions.

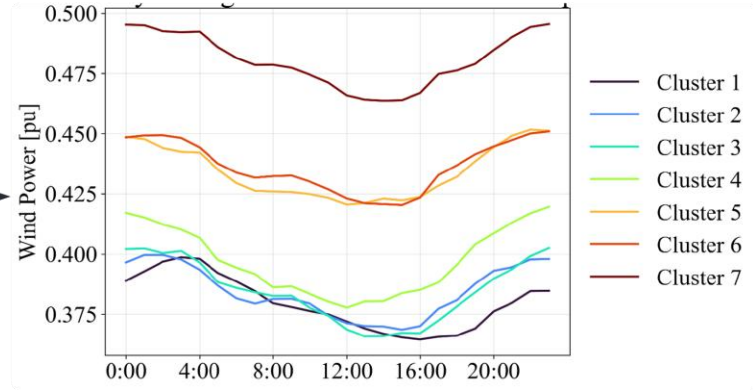
Methodology Overview

- CRSES built a GIS-based tool to pinpoint the best locations for wind and solar projects — fast, accurate, and informed by real-world constraints.
- It combines validated hourly resource data with spatial exclusion zones and infrastructure filters.
- The model identifies areas with high-capacity factors that align with daily and seasonal demand patterns.

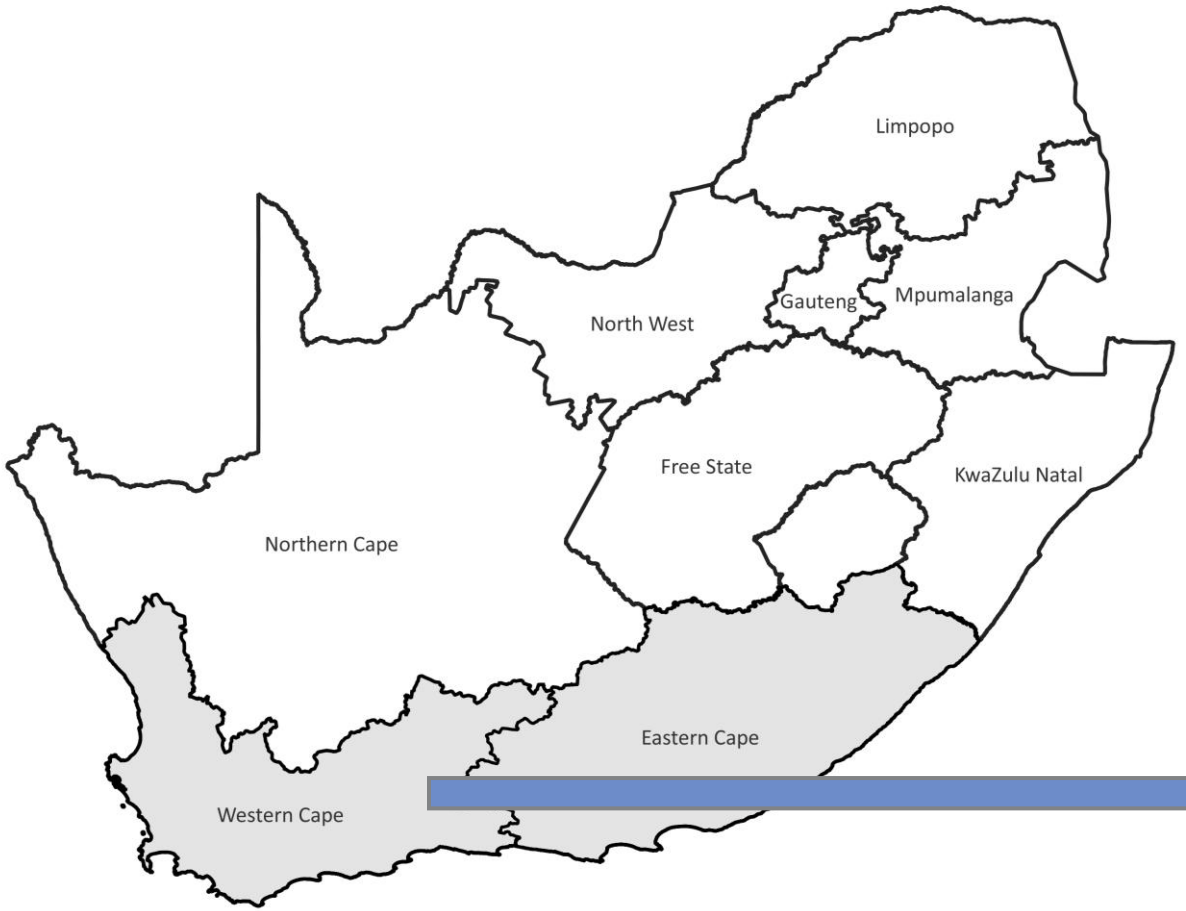
Geospatial Modelling Framework

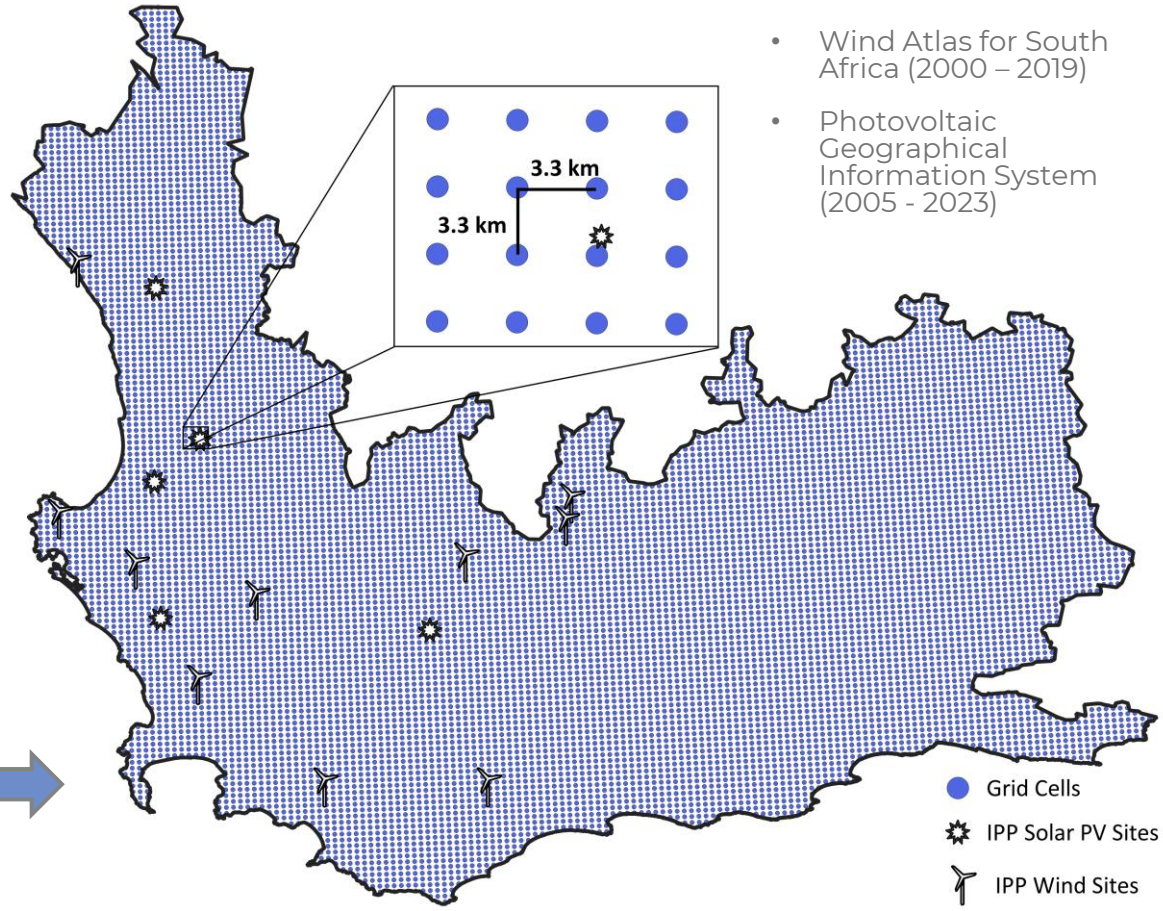






Renewable Resource Construction & Validation





Datasets:

- Wind Atlas for South Africa (2000 – 2019)
- Photovoltaic Geographical Information System (2005 - 2023)

Environmental Impact Assessment - Features of Critical Importance (FCI)

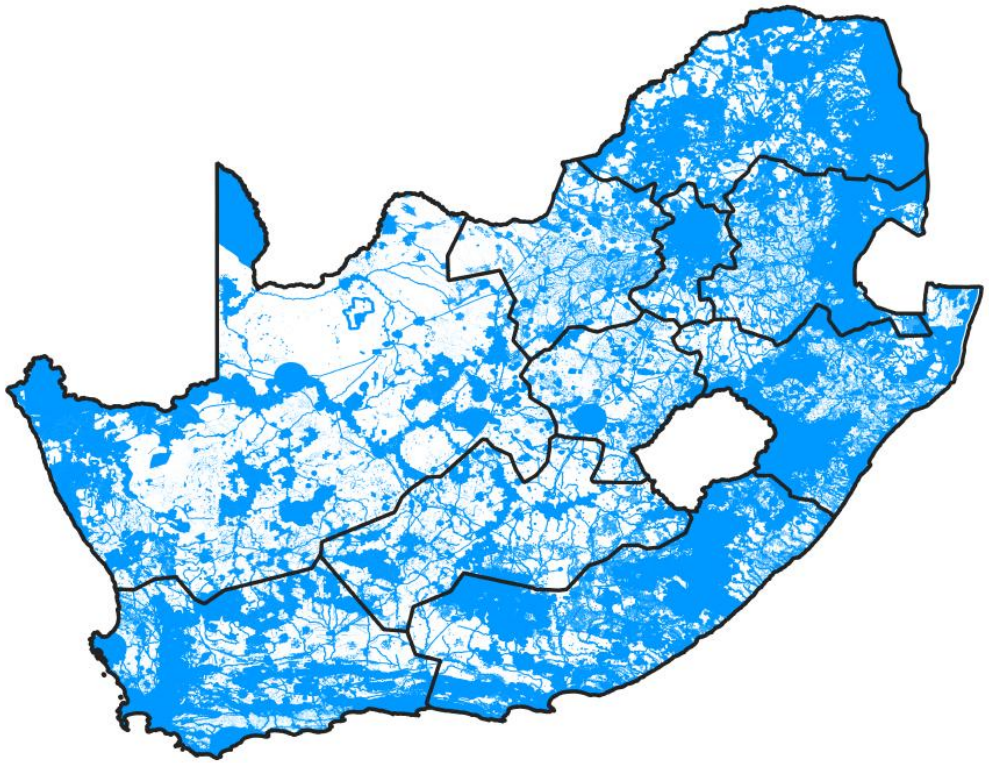
Ref	Criteria	Features	Wind Buffers	Solar Buffers
[1]	Protected Areas	Forest Nature Reserves	3 km	1.5 km
		Forest Wilderness Areas	3 km	1.5 km
		Marine Protected Areas	-	-
		Mountain Catchment Areas	-	-
		National Parks	5 km	2.5 km
		Nature Reserves	3 km	1.5 km
		Protected Environments	3 km	1.5 km
		Special Nature Reserves	3 km	1.5 km
		World Heritage Sites	5 km	2.5 km
[2]	Critical Biodiversity Areas (CBAs)	CBA1, CBA2	-	-
[2]	Large Water Features	Estuaries, lagoons, lakes, state dams	1 km	500 m
		Major rivers	1 km	500 m

Ref	Criteria	Features	Wind Buffers	Solar Buffers
[3]	Agricultural Land Capability	Very high sensitivity areas (categories 11-15)	-	-
[3]	Field Crop Boundaries	Pivot, Shadenet, Horticulture, Viticulture	-	-
[2]	Birds	Important bird areas	-	N/A
[2]	Heritage	All grades and declared sites	-	-
[2]	Defense	All SANDF defense features	-	-
[4]	Major Airports	-	8 km	-
[4]	Towns, Settlements, Small Airfields and Landing Strips	-	2 km	500 m
[4]	National Roads, Main Rail lines, and Coastlines	-	1 km	1 km

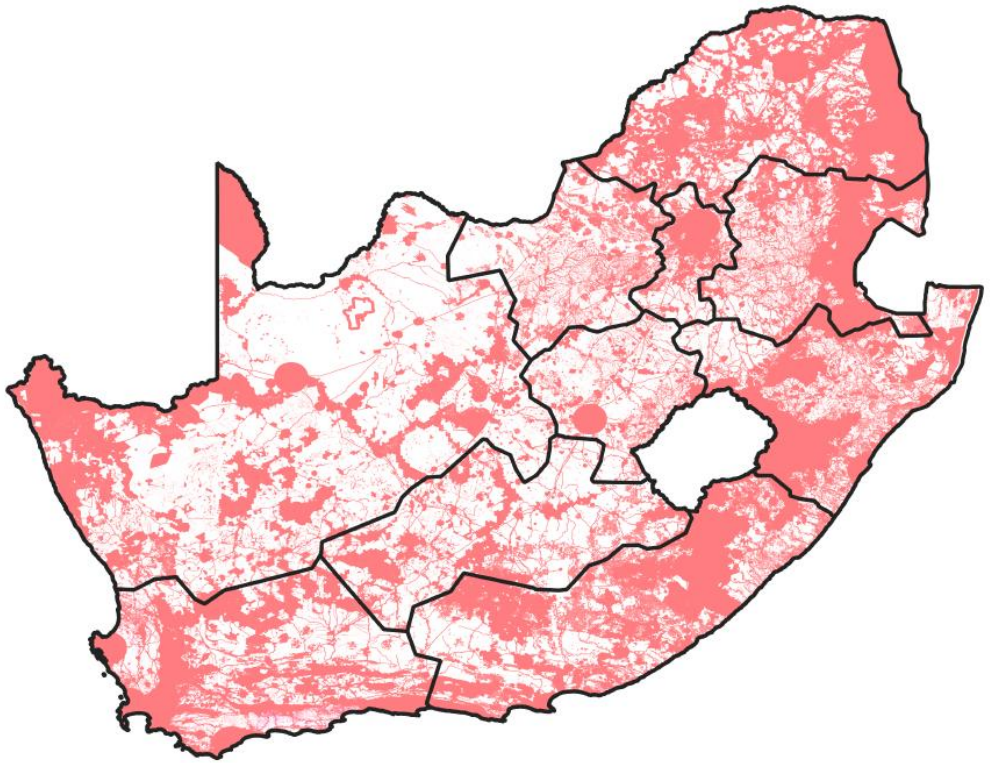
	References
[1]	Department of Forestry, Fisheries and the Environment, "GIS Data Downloads," 2023. [Online]. Available: https://egis.environment.gov.za/data_egis/data_download/current.
[2]	South African National Biodiversity Institute, "Biodiversity GIS," 2023. [Online]. Available: http://bgis.sanbi.org/.
[3]	Department of Agriculture, Forestry and Fisheries, "National Screening Tool," Environmental Affairs, 2021. [Online]. Available: https://screening.environment.gov.za/screeningtool/.
[4]	Stanford University, "Earth Works - Geospatial data," International Steering Committee for Global Mapping, 2016. [Online]. Available: https://earthworks.stanford.edu/.

Environmental Impact Assessment - Features of Critical Importance

FCI areas for wind development

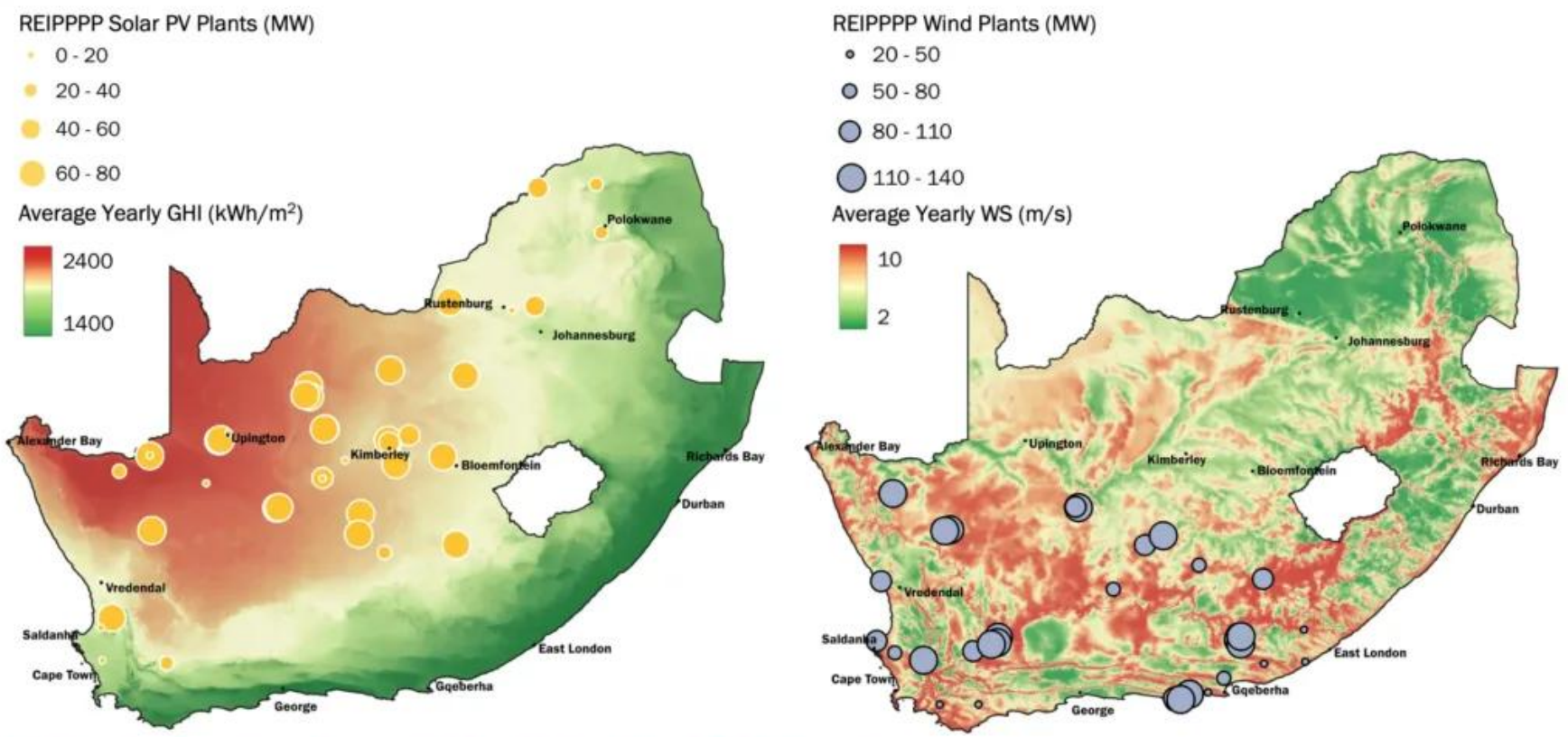


FCI areas for Solar development



Areas with Higher Capacity Factors

South African REIPPPP Solar PV and Wind Plants



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Source: Eskom 2025a. Notes: REIPPPP: Renewable Energy Independent Power Producer Procurement Programme; GHI: Global Horizontal Irradiance.

Time of Use (ToU) Clustering

Time-of-use analysis involves aligning wind and solar resource profiles with Eskom's predefined tariff periods, enabling an economic and temporal assessment of energy availability. This process allows for the identification of optimal renewable energy sites based on their performance during peak, standard, and off-peak periods across different demand seasons.

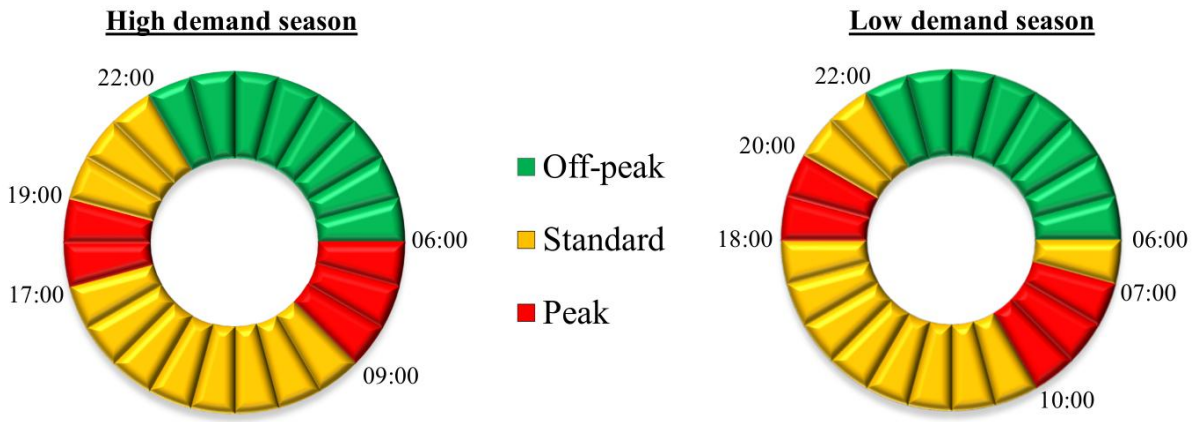
TOU Tariff Periods:

- Low-Demand Season (September – May)
- High-Demand Season (June – August)
- Daily TOU Categories:
  - Peak: High electricity demand, highest tariff rates.
  - Standard: Moderate demand, intermediate rates.
  - Off-Peak: Low demand, lowest rates.

Feature Extraction Methodology:

- For each TOU period, statistical features are extracted to quantify energy availability and variability.
- The mean (μ) represents the average resource availability for each TOU period.
- The standard deviation (σ) captures the fluctuations in energy generation, indicating resource stability.

ToU Megaflex period definition

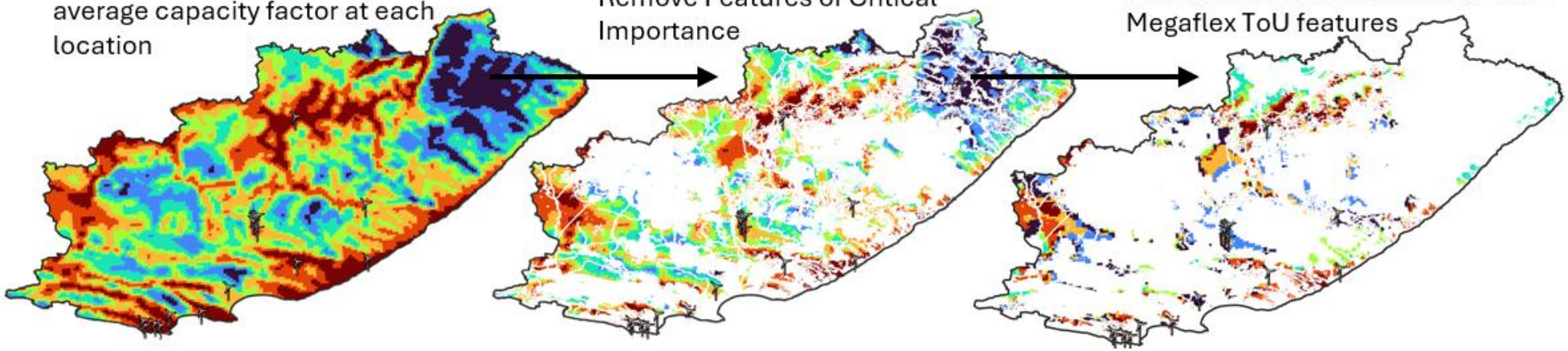


Methodology Summary

Characterise region based on the average capacity factor at each location

Remove Features of Critical Importance

Keep regions with average Capacity Factors above a defined percentage and cluster the locations based on Megaflex ToU features

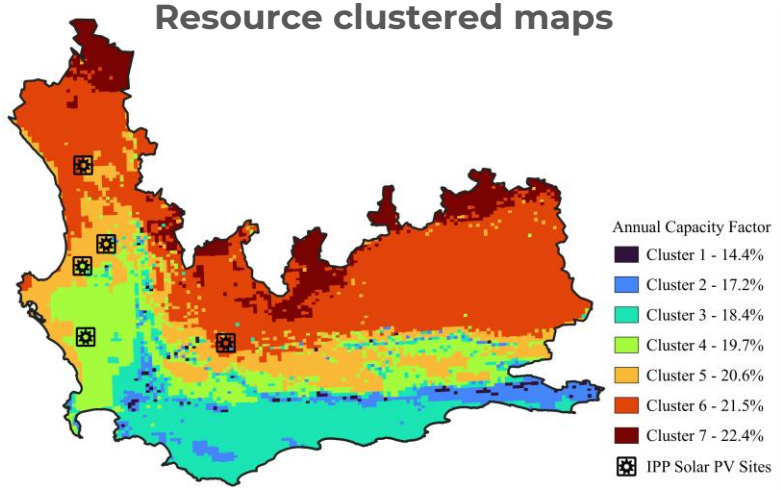


Resource clustered map (left) and probability densities for each cluster (right)

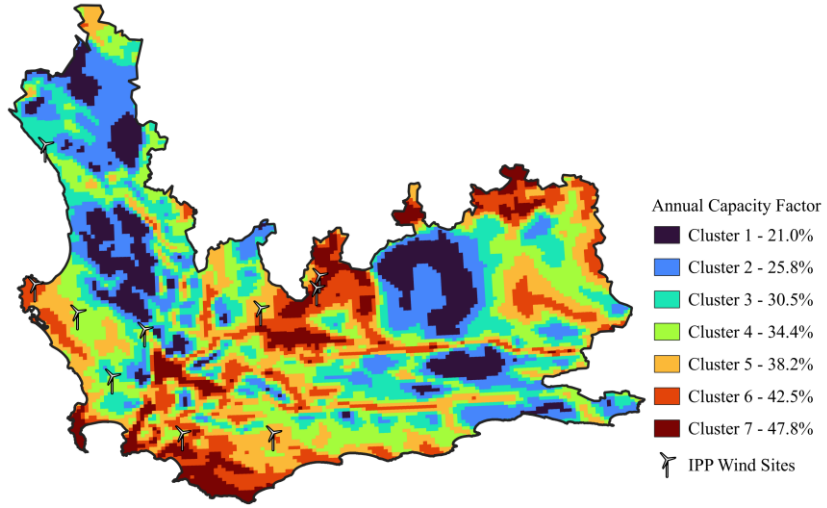
Western Cape Wind and Solar PV Resource Maps

Resource clustered maps

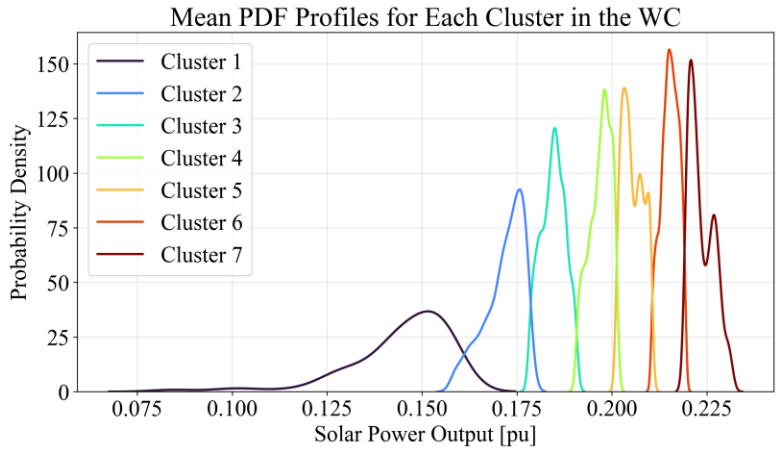
Solar PV Power map

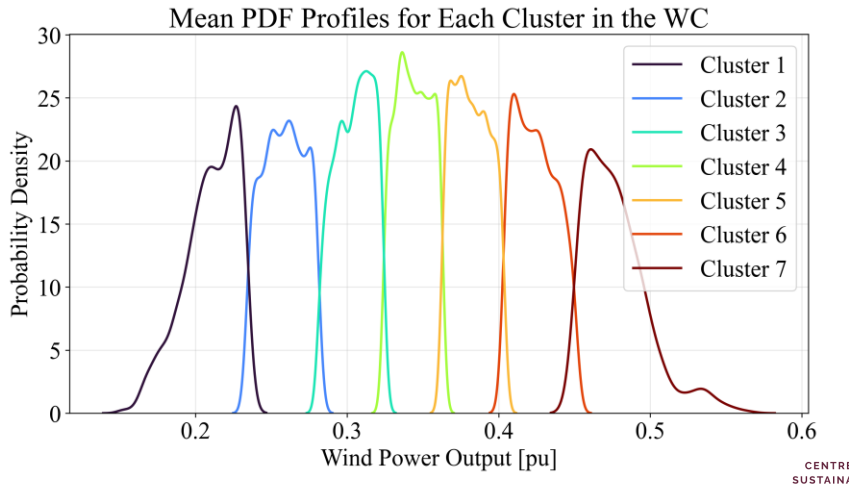


Wind Power map



Probability densities for each cluster





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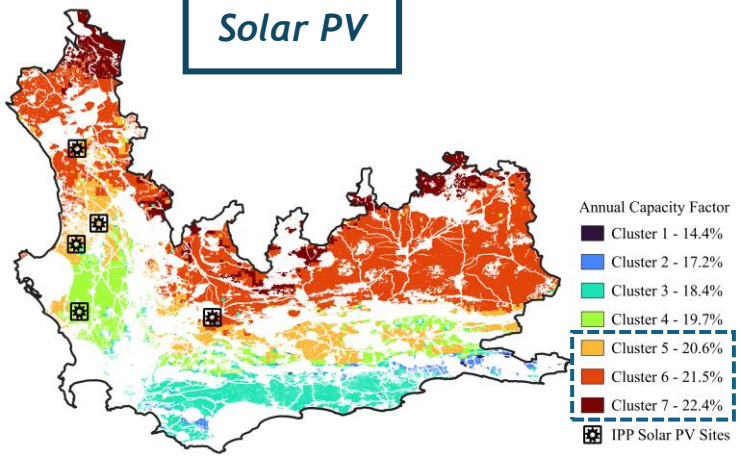
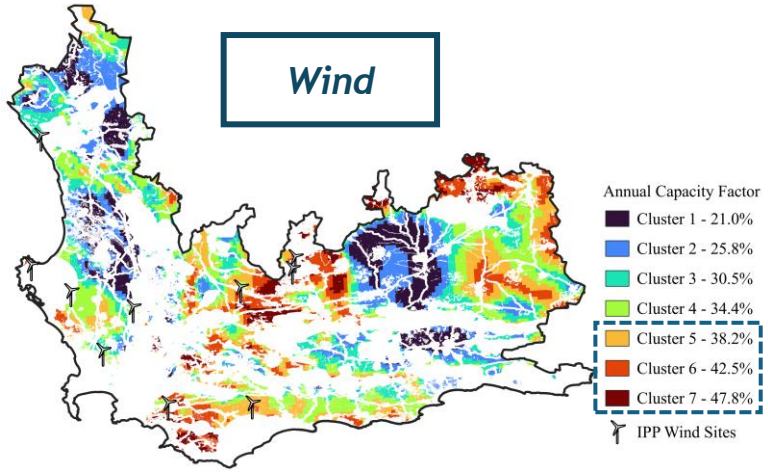
Resource clustered map (left) and probability densities for each cluster (right)

Western Cape Wind and Solar PV Resource Maps with Exclusion Zone

Solar PV



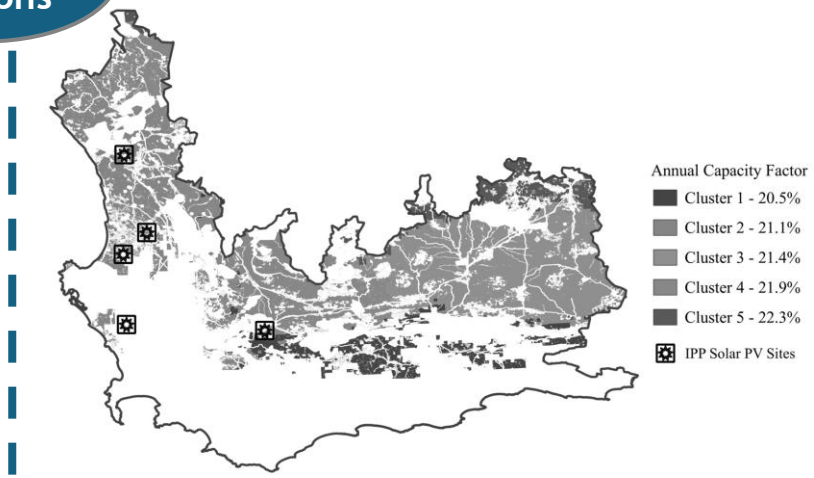
Wind



Solar PV > 20%

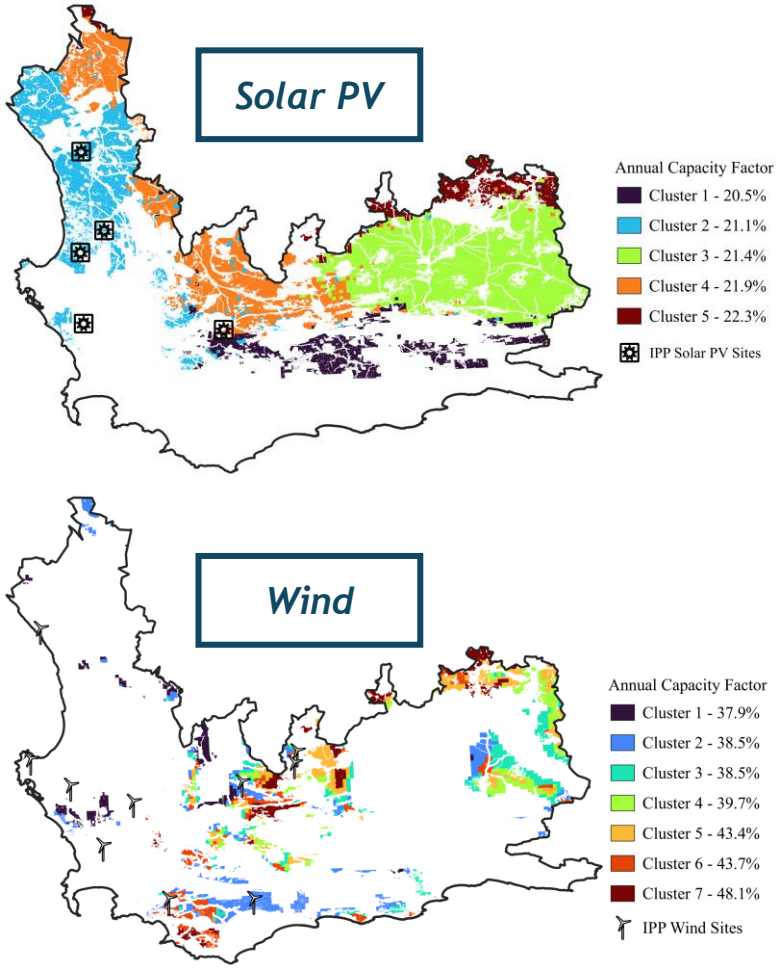
Wind > 35%

High CF Regions

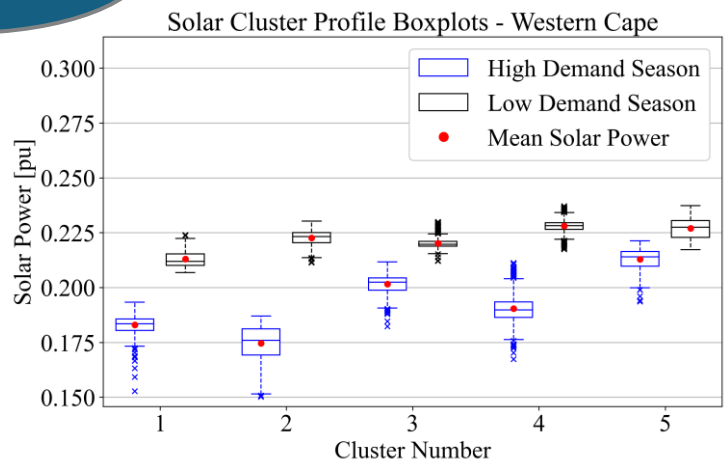


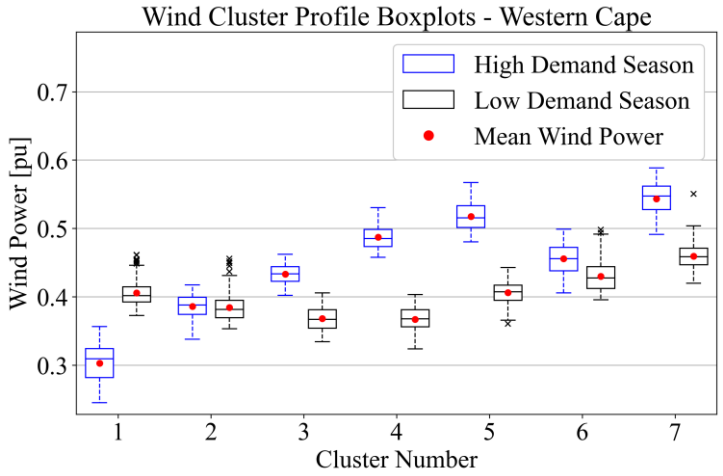
Resource clustered map (left) and probability densities for each cluster (right)

Time of Use Clusters for Wind and Solar PV in the Western Cape



Cluster Characteristics





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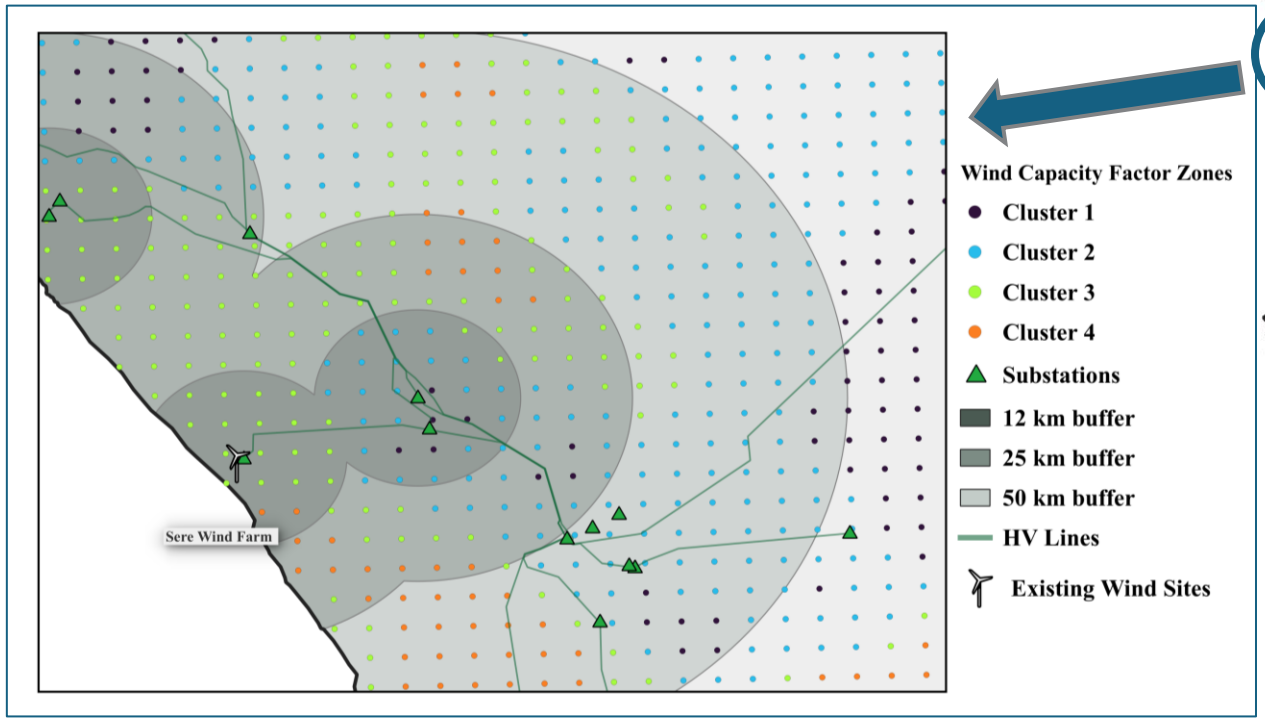
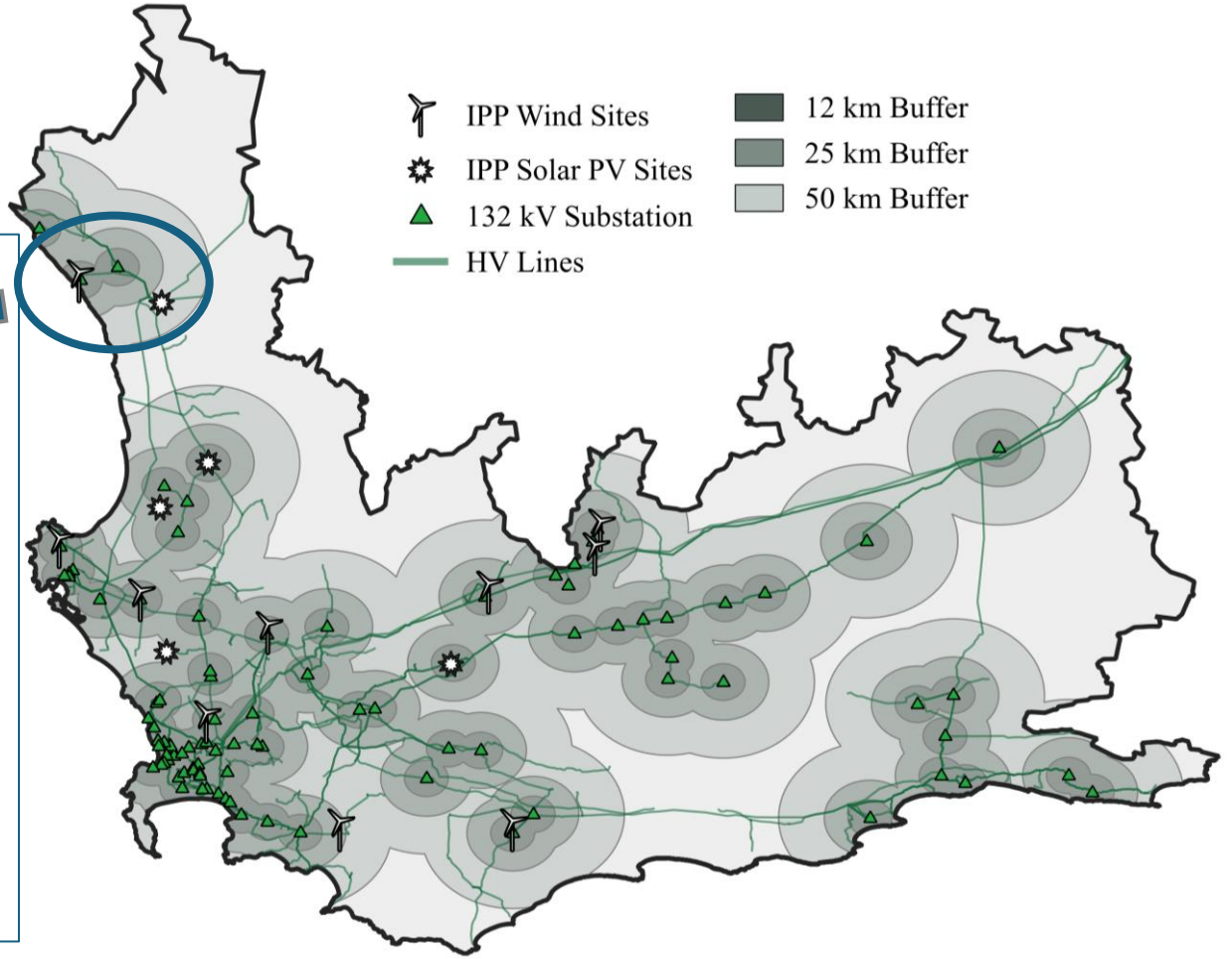
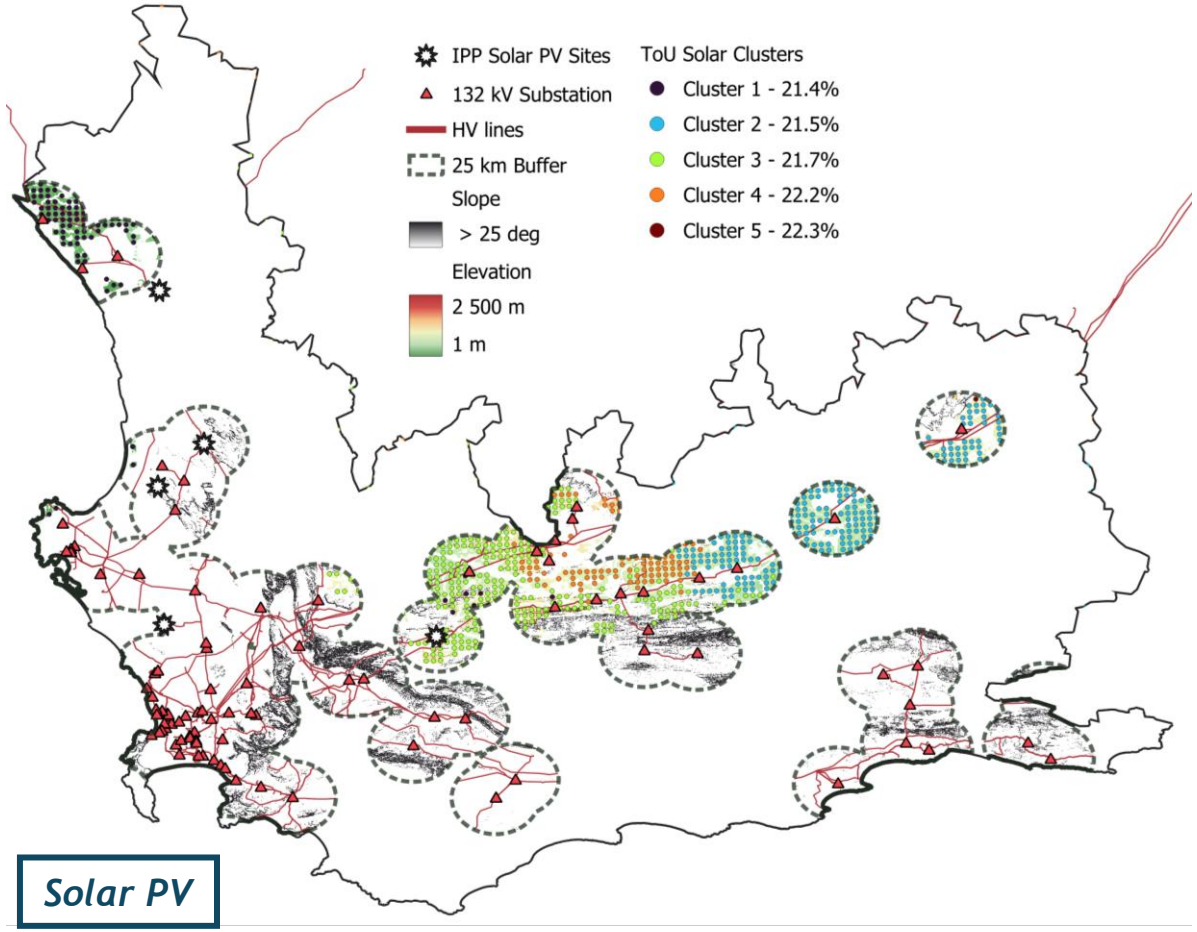
Electrical Infrastructure Mapping

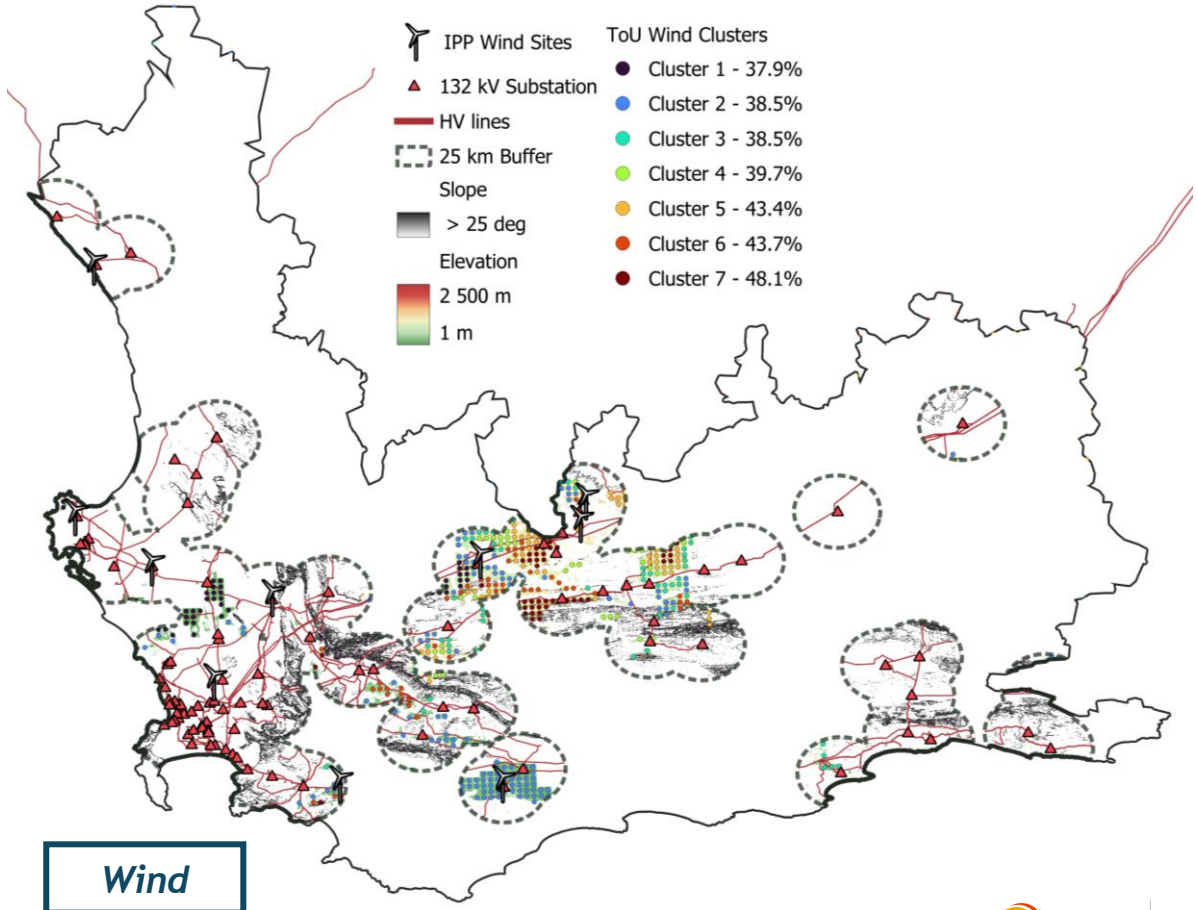




Site-Level Assessment with Terrain and Grid Considerations for the Western Cape

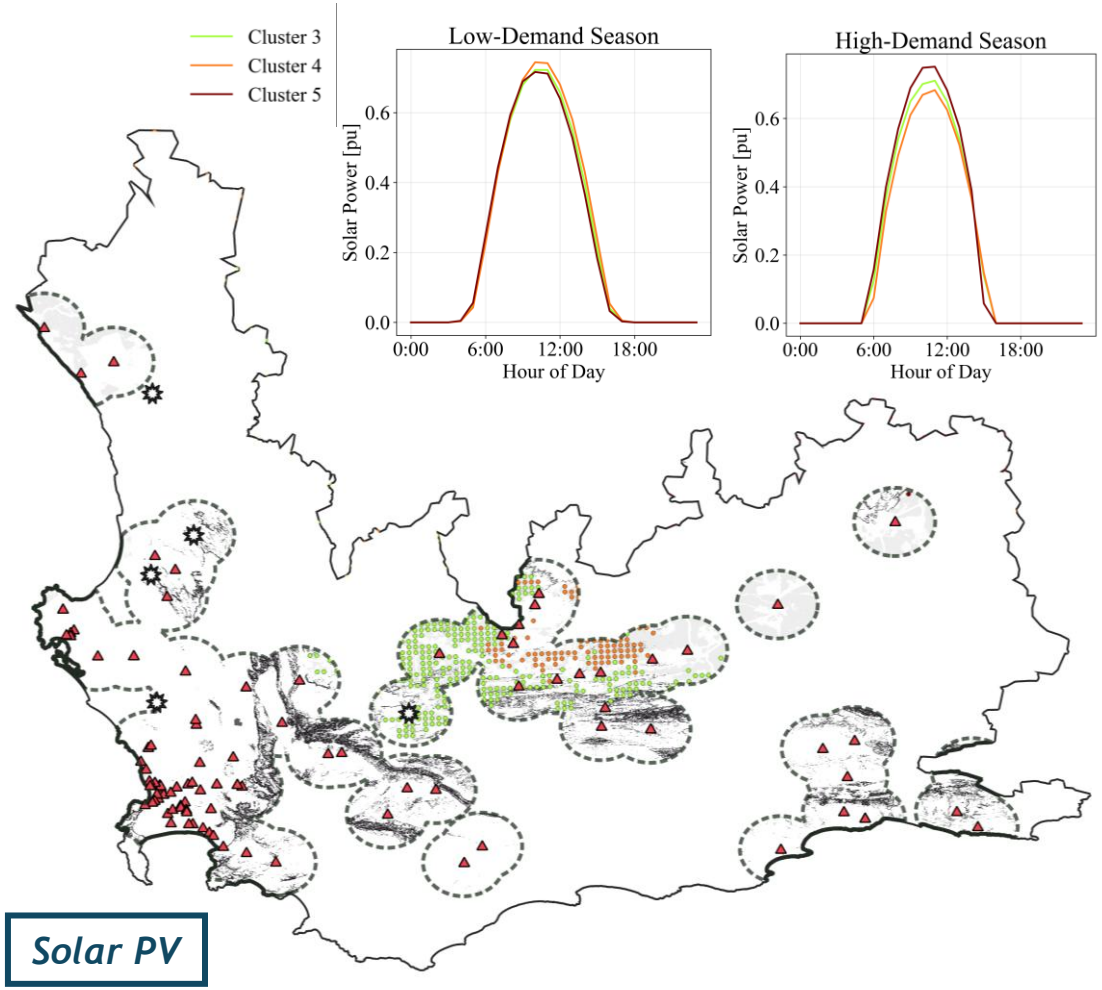


Solar PV

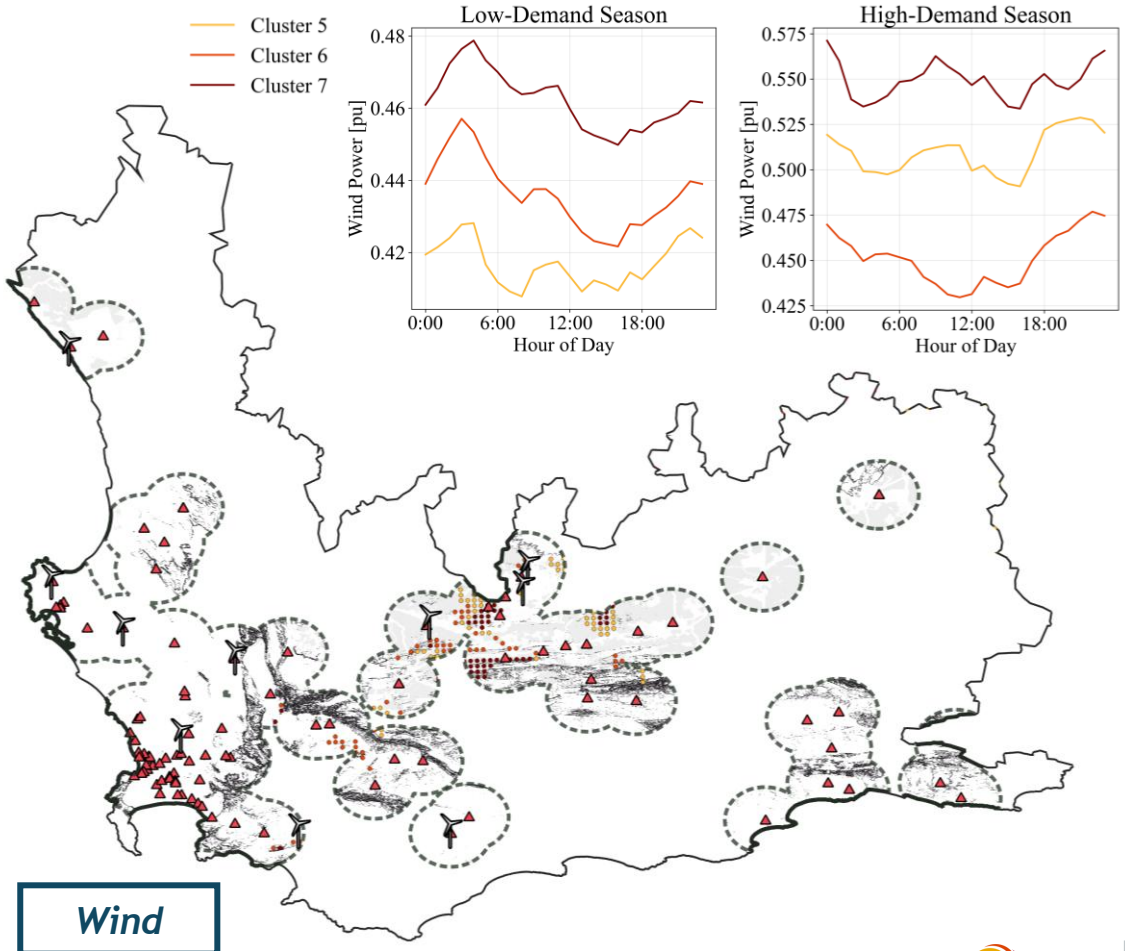


Wind

Site-Level Assessment with Terrain and Grid Considerations for the Western Cape



Solar PV



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Other applications

Extending the Framework

Beyond resource mapping, the model serves as a foundation for broader applications.

Strengths:

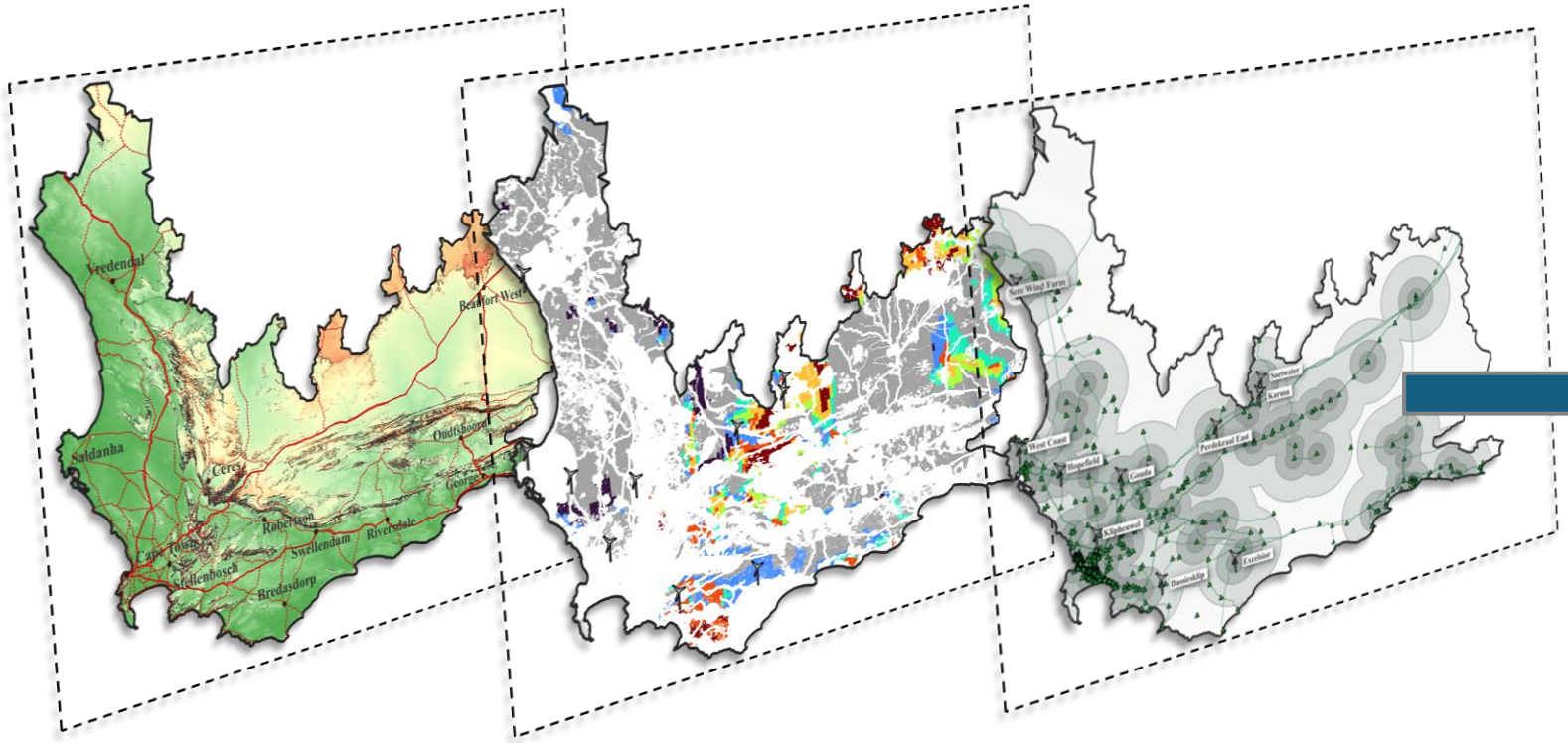
- Comprehensive national resource atlas: clear picture of wind and solar potential across South Africa
- Tailored scenario inputs: ready-to-use profiles for capacity-expansion, production-cost and grid-stability studies
- Site-selection guidance: pinpoint high-yield areas for new renewable farms or transmission investments
- Independent planning tool: support for transmission-upgrade roadmaps and targeted renewable-energy roll-out

Potential Uses:

- Regional energy planning: Build provincial-level resource atlases.
- Scenario modelling: Provide representative renewable profiles for system simulations.
- Infrastructure coordination: Support network-expansion and storage-planning studies.
- Policy and permitting support: Assist in preliminary screening and spatial planning.
- Grid optimisation: Integrate with power-system models to test how renewable siting affects load variability and ramping.

Conclusion

- The geospatial model provides a practical framework for assessing renewable potential and planning future projects.
- Combining spatial, temporal, and environmental data supports more reliable and sustainable site identification.
- The clustering approach captures regional diversity and improves planning efficiency.
- The framework can evolve toward optimisation applications to improve grid stability and renewable integration.



Optimal Renewable Sites

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CONTACT DETAILS

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