# Integration of hydropower and wind for Green Regional Energy production in Southern Africa

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# Background: Renewable resources

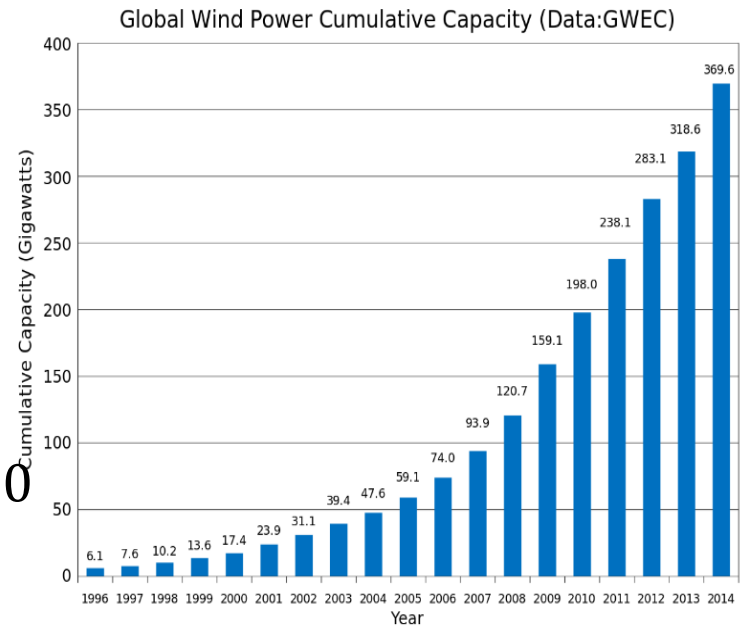
## Renewable Energy resources

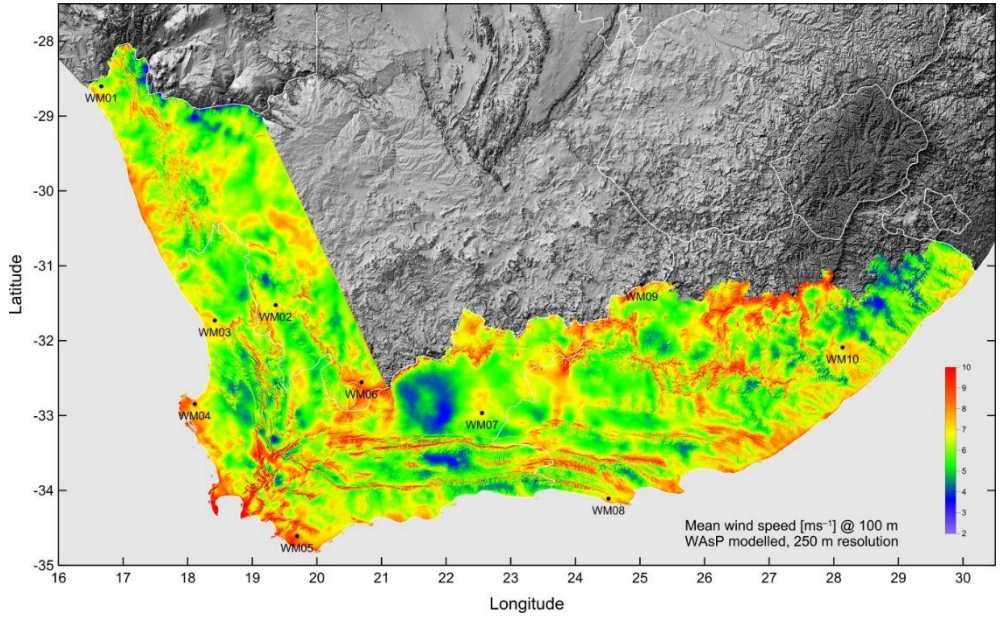
- Affordable, low-cost ,clean and environmentally friendly solutions

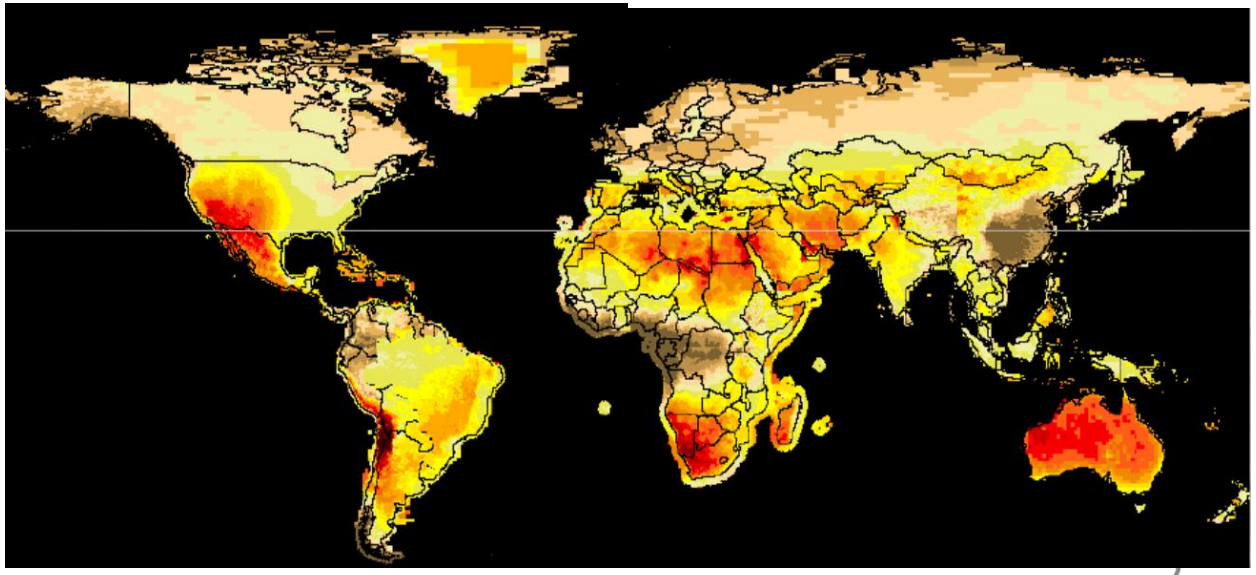
## Current Global Capacity

WIND: 370 GW (by 2014) expected to grow 2,000 GW by 2040

SOLAR (PV& CSP):142 GW (by 2013) expected grow 5,600 GW by 2050



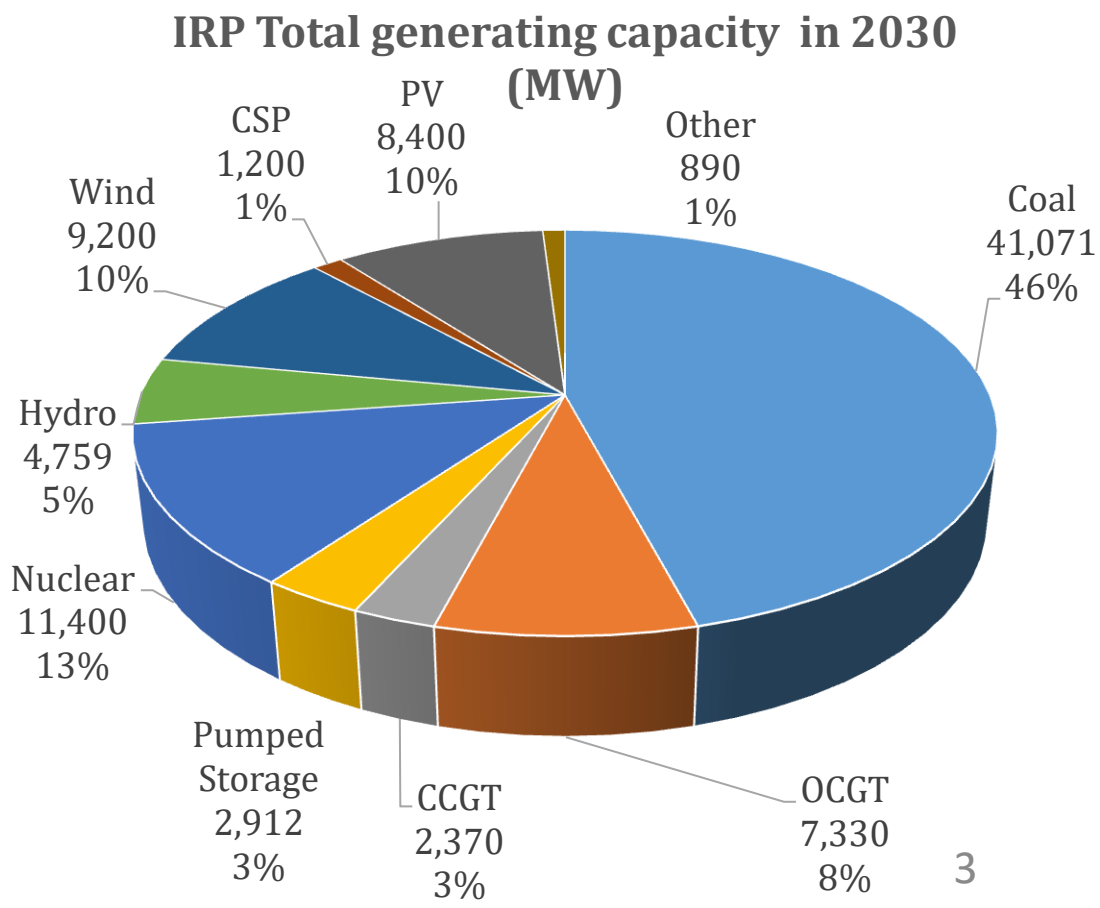



Solar Resource Potential Worldwide

# Background: Visions and Future plans

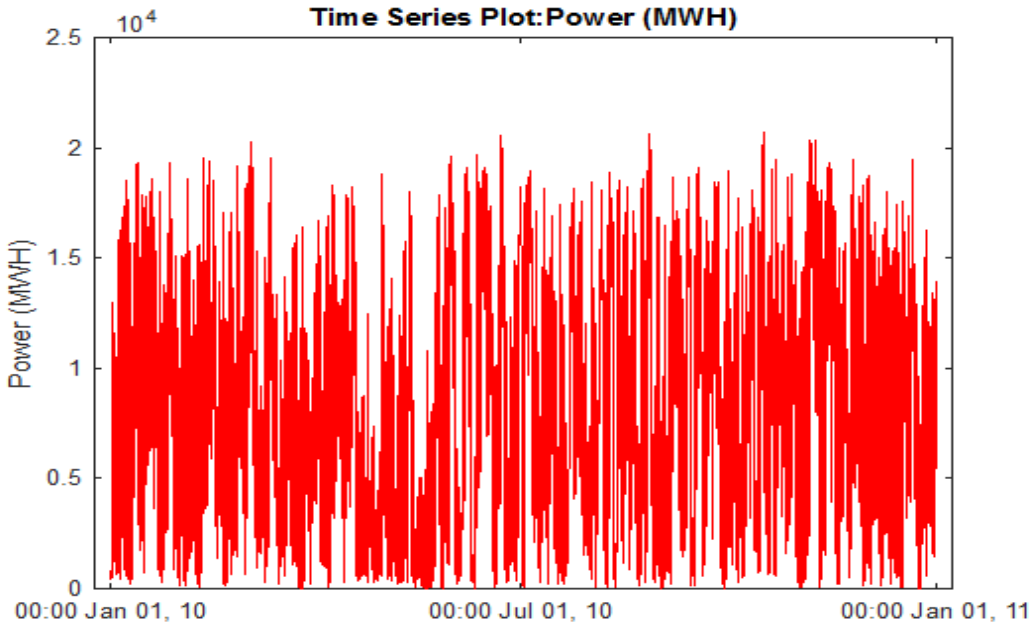
- The government's Integrated Resource Plan (IRP) for the power sector wind and solar power (WSP) to provide 21% of generating capacity by 2030.

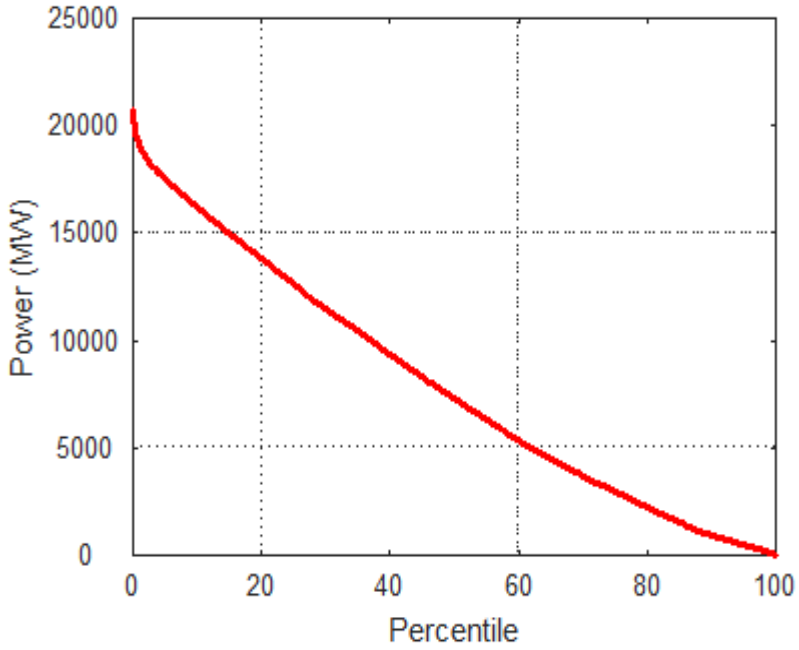
| | ***Capacity (MW)*** | ***% Total*** |
|---|---|---|
| IRP (2010) Updated by 2030 | 17,430 | 21% |
| WWF Vision by 2030 | 35,018 | 37% |
| Eskom 2012 "Green scenario" by 2040 | 46,500 | 41% |



# Background: Challenges & Opportunities

- Inherently intermittent
- Non-dispatchable source of Energy




✓Regional Hydropower and Storage facility -> battery
✓Wind Generating Capacity 23,000 MW
✓HP Capacity 9,600 MW

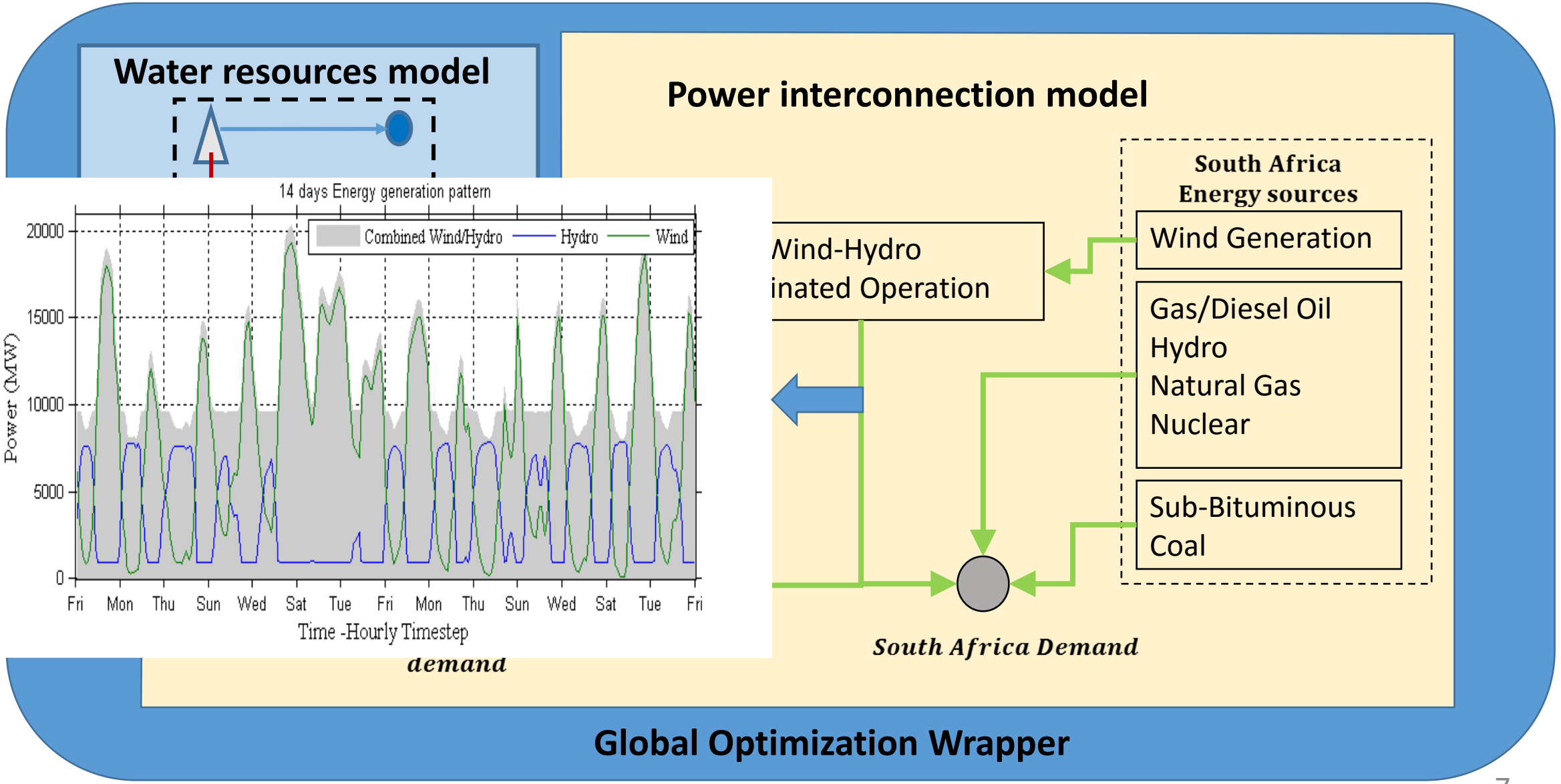
# Objective and Scope of Study

- Can regional coordinated operation wind-hydro results in better utilization of resource?
- Assuming perfect coordination, how should the reservoirs be operated?
- What will be the implication on Demand-Supply of Energy?
- What is the critical constraint in the integrated operation model ?
  - Coal Flexibility , Storage

# Methodology: Main elements

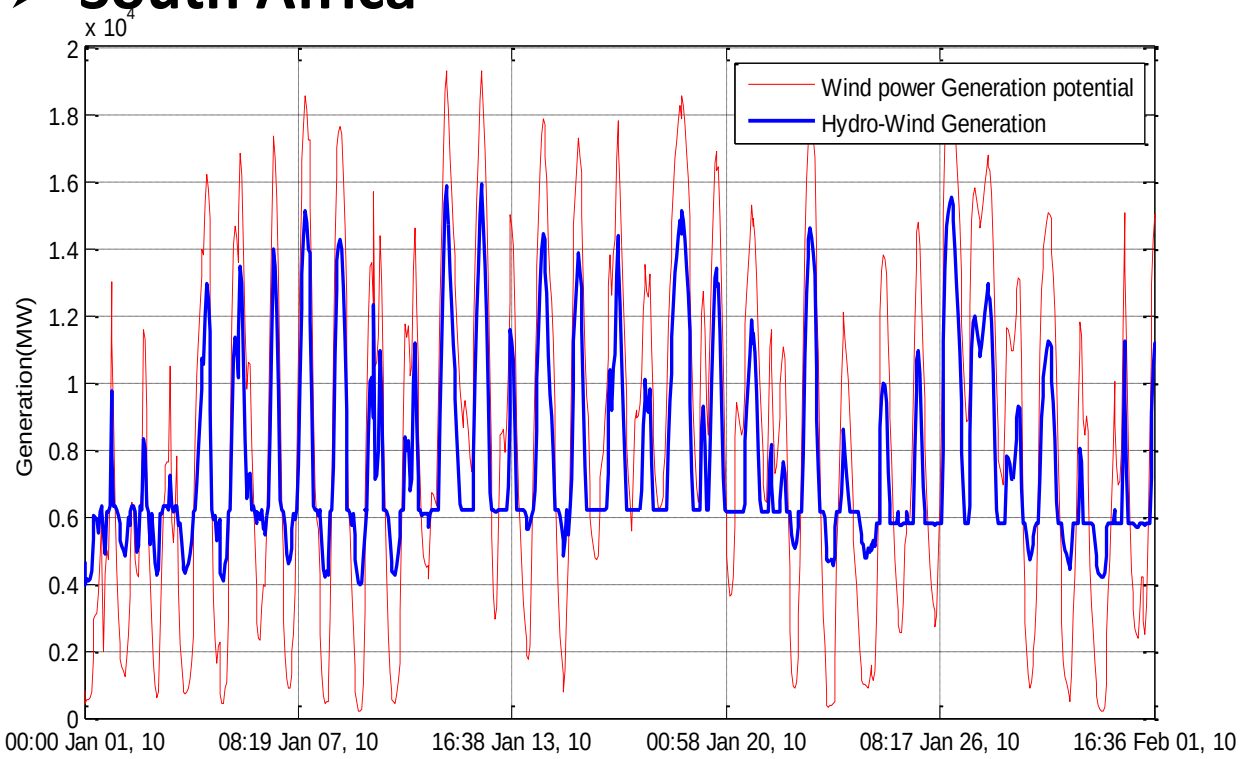
- Perfect foresight wind generation pattern
  - Hourly wind generation 2010
  - Hourly demand
- Water resources model for a system of reservoirs in Zambezi basin
  - Hourly Time step
  - Policy and non Policy constraints
  - Priority based water allocation
- Power interconnection model
  - Single node energy balance model
  - Cost-price not included
- Global Optimization tools
  - Optimum allocation spatially across different facilities
  - Optimum allocation of resource over entire period

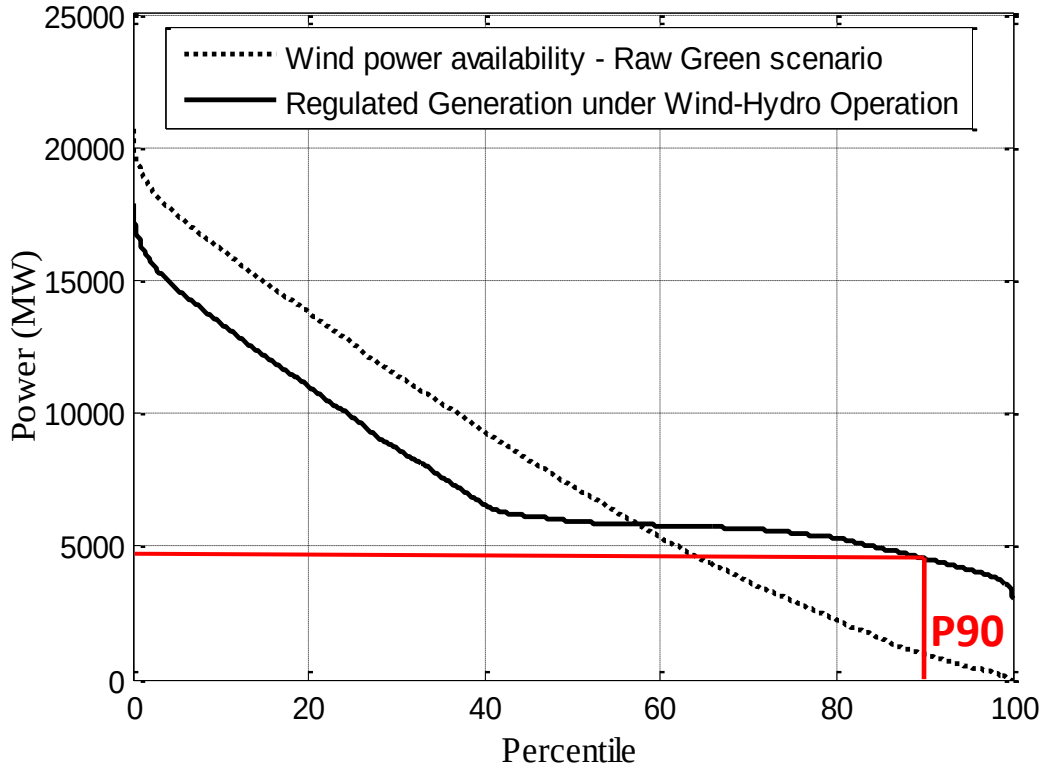
# Methodology: Model Framework



# Result: Firm Generation of Combined Power

## ➢ South Africa




Power duration Curve for wind-hydro Operation

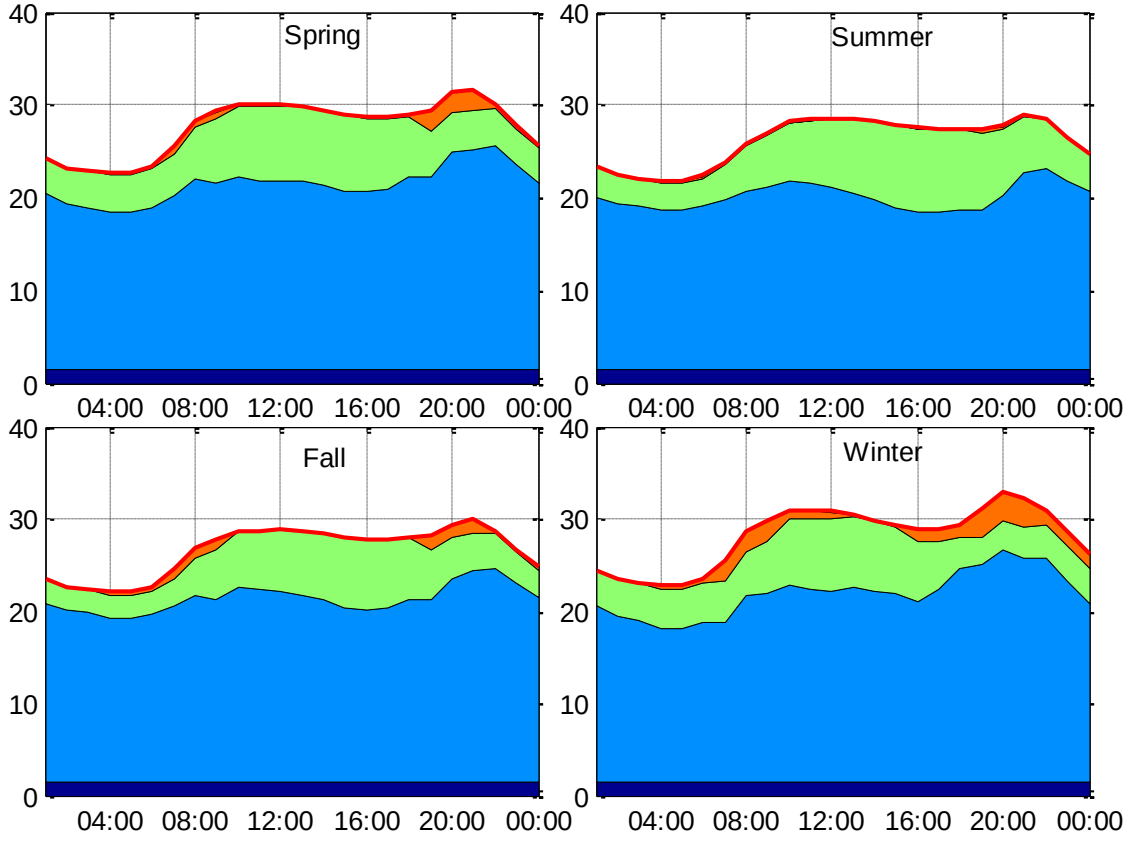
## ➢ HP facilities in Zambezi

Higher Reliability of meeting Power Target => No Unmet demand

# Result: Implication of Demand-Supply in South Africa

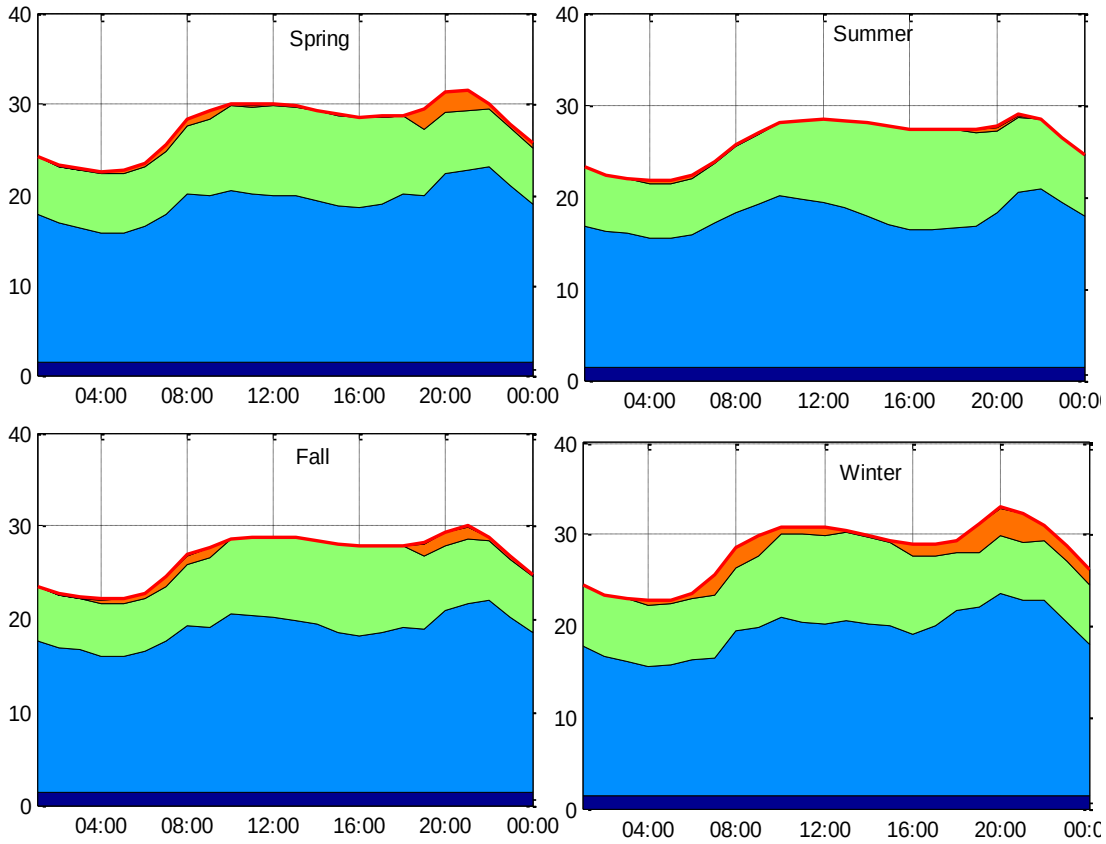
**Reference scenario**

Penetration:13%.




**Wind-Hydro Operation**

Penetration:18.7 %.

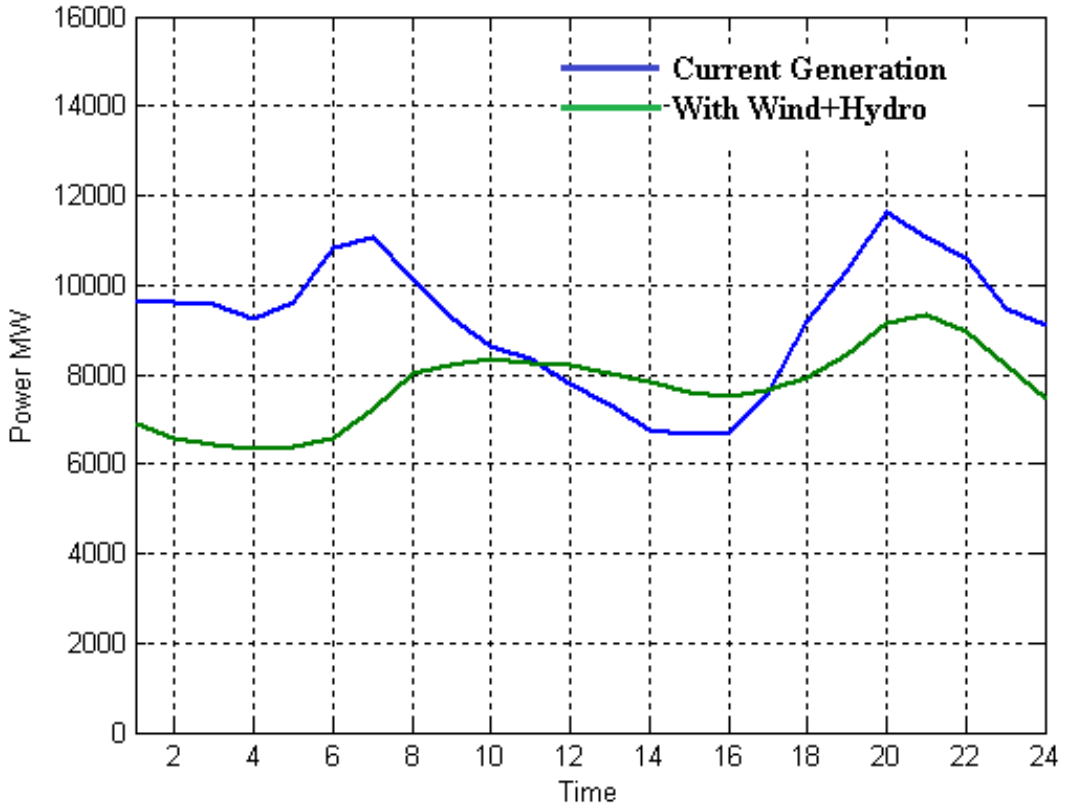




Mean diurnal profile of energy supply to meet South Africa's Demand

# Result: Implication of Demand-Supply in South Africa

- Less load following role for Coal plants
  - ➢Efficient resource consumption
  - ➢Better life of facility



# Remarks

## ➢Summary

- Given the Current storage and the generating Capacity 90p capacity of wind power under coordinated operation from 4530 MW
- Based on demand-Supply of energy in South Africa , up to 18.7% penetration
- Implication on existing power Target for Zambezi – Improved reliability of power supply
- Less Cycling requirement on Coal power plants

## ➢Conclusion

- Need for strong regional cooperation in both planning & operation to achieve national goal and regional win-win solutions .

- Integration operation should be considered when planning new hydropower schemes to accommodate coordination with other intermittent resource.

# Thank you

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