Development and Application of a Short Term Power Forecasting Model for Large Grid Connected Photovoltaic Systems

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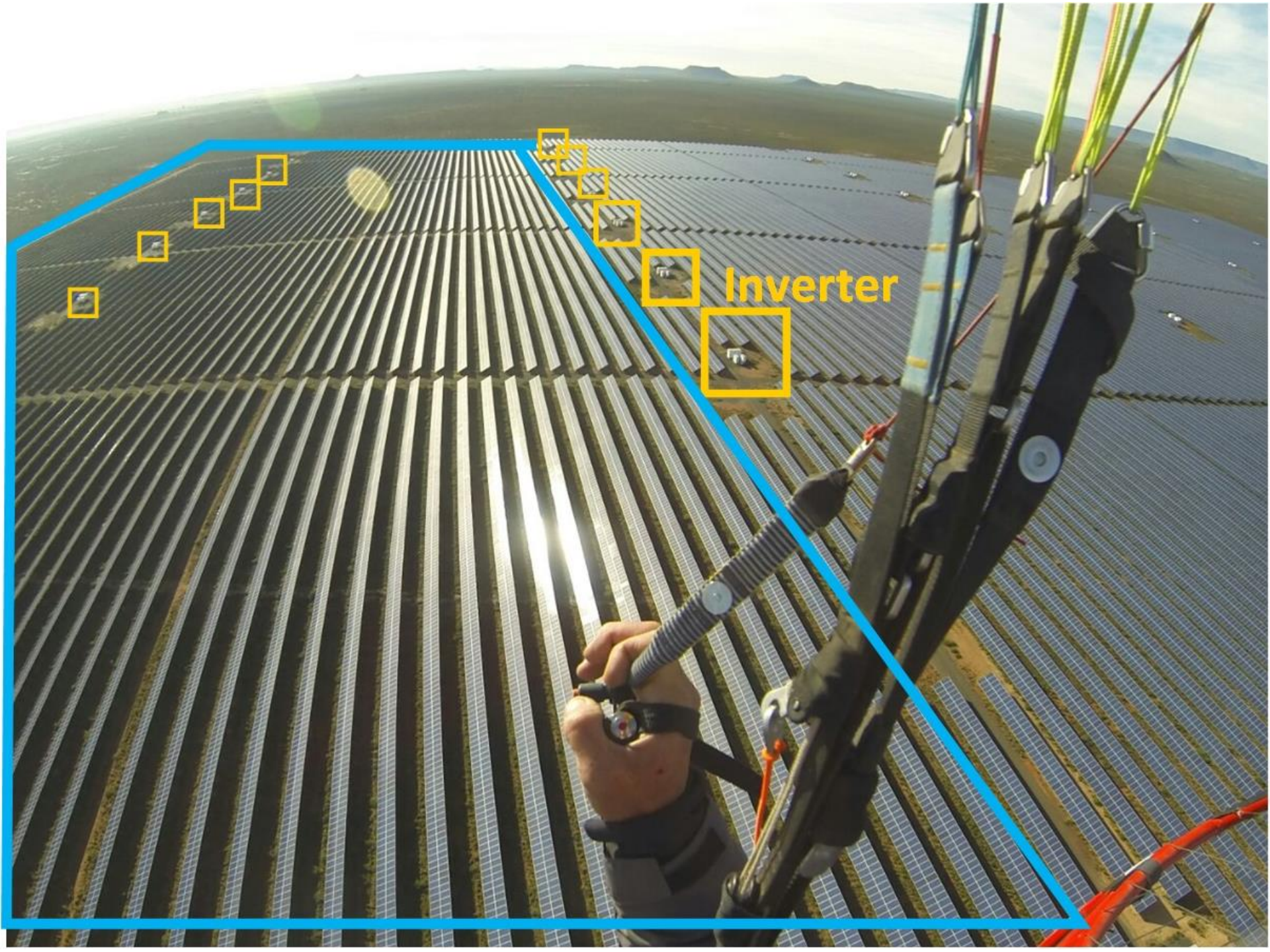
- Why is South Africa's energy demand not 100 % supplied by solar power?

- Solar power is extremely volatile
- Dependent on atmospheric & environmental variables (irradiance, wind, temp, etc…)

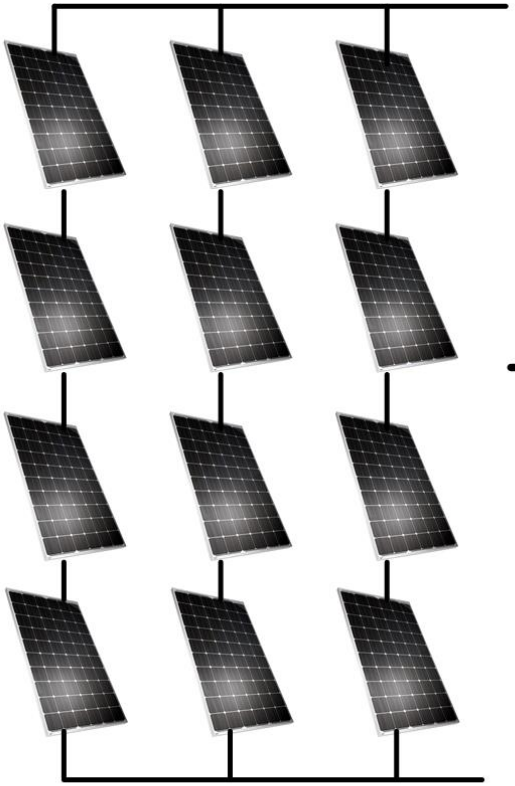
- Volatile energy source = electrical grid instability, which biases power utilities against dominant PV supply

Solution…PV forecasting

- What if we could inform electricity providers (ESKOM) of future state of PV power (availability, disruptive events) ?
- Forecasting – Accurately predict PV output
- Enables better grid coordination (scheduling, operation)
- Increases network stability
- Incentive for large scale adoption of PV


Inverter


SUNNY CENTRAL
SMA

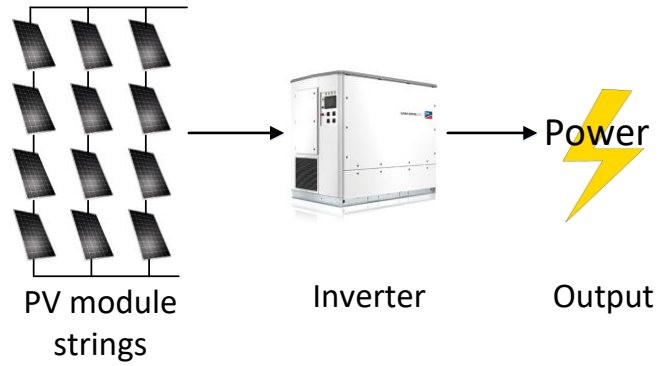


PV module strings

Inverter

Power

Output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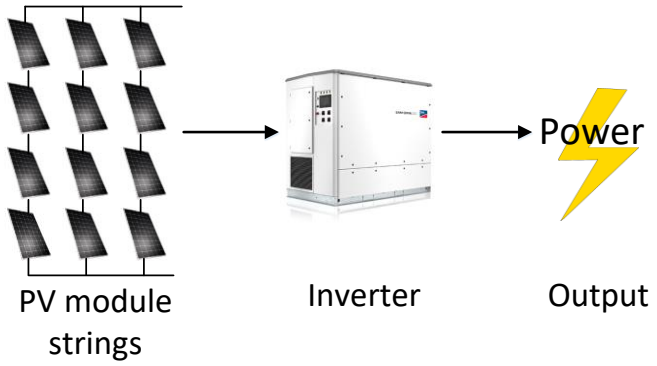
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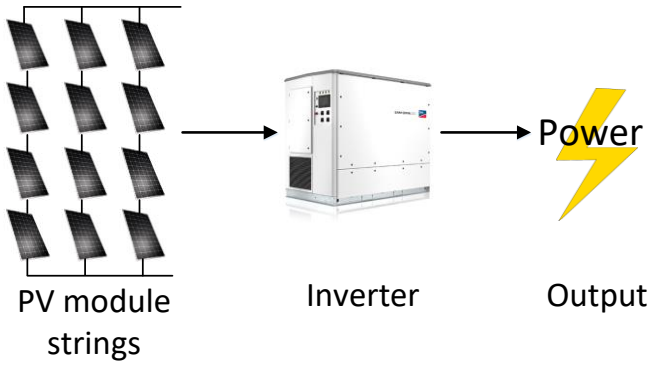
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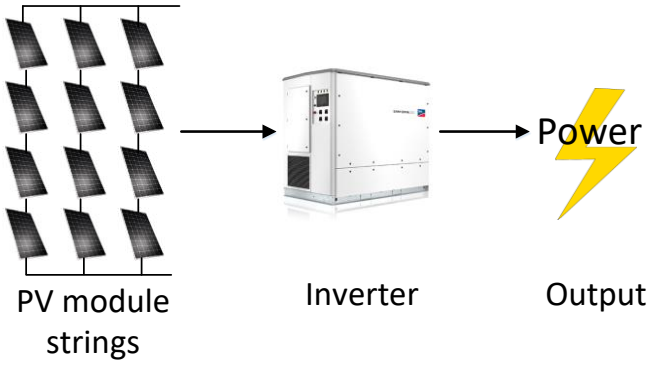
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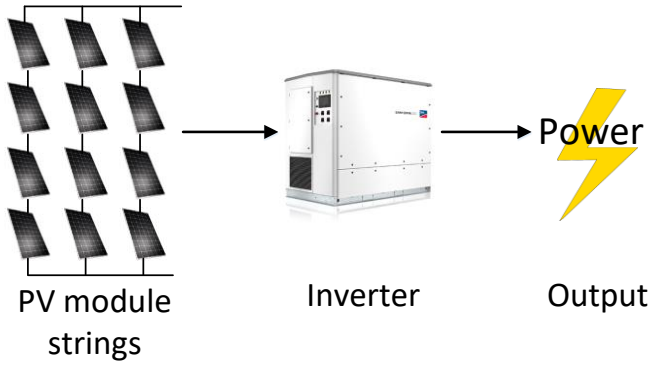
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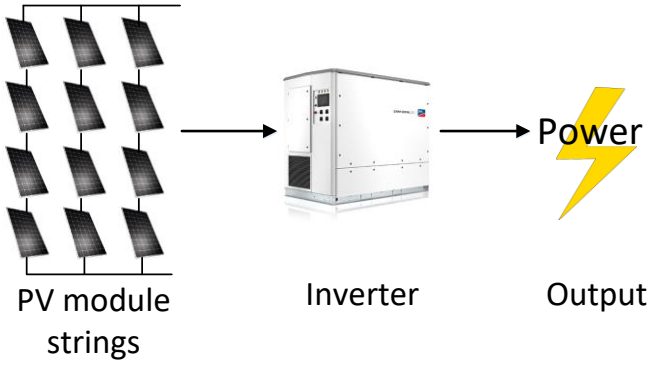
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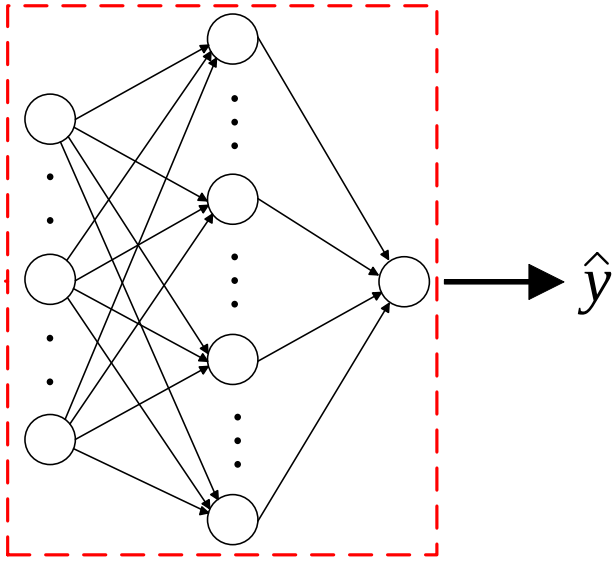
Traditional PV forecasting process

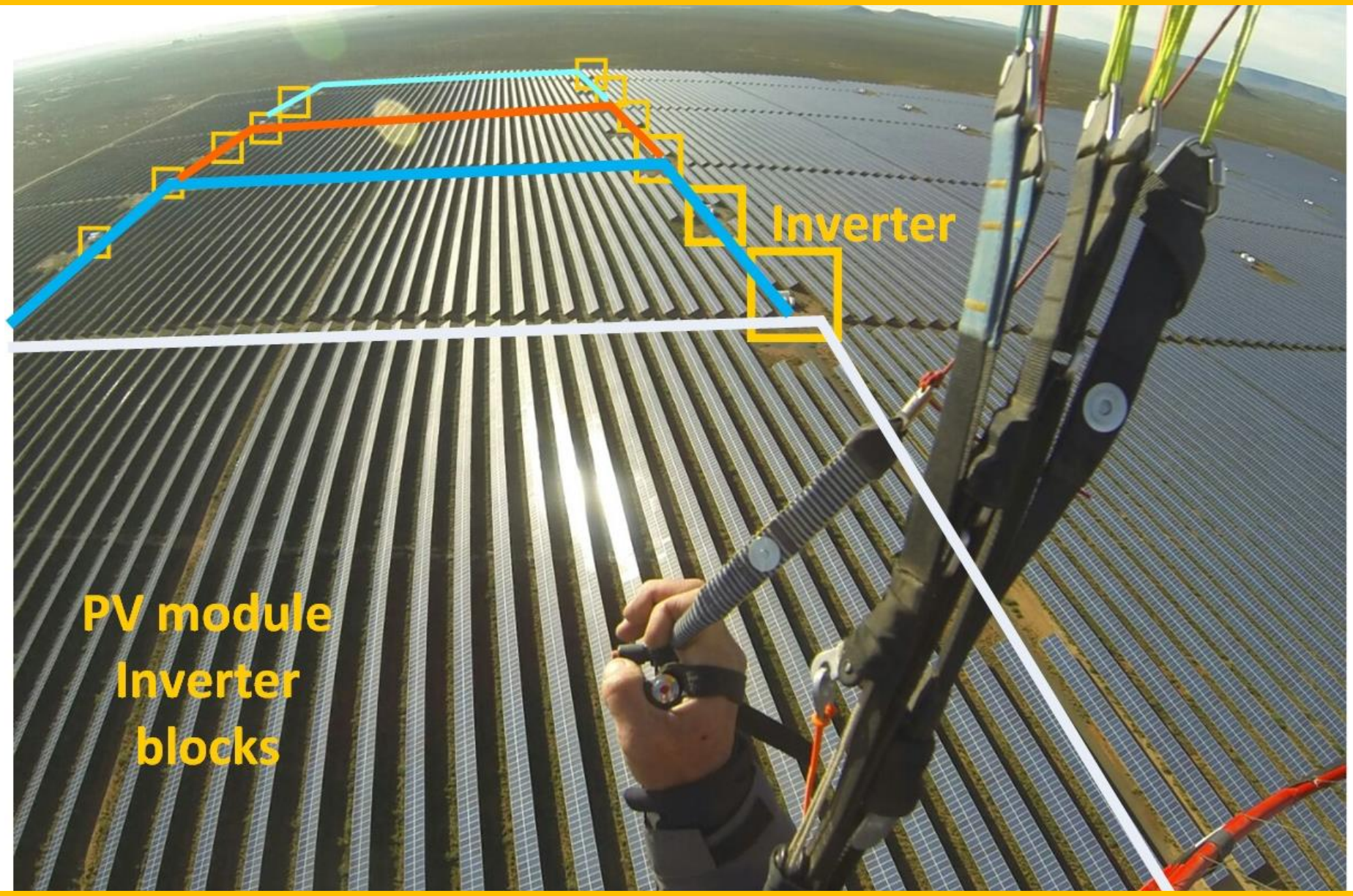


- Hypothesis: Disregards important micro-level information

Problem statement

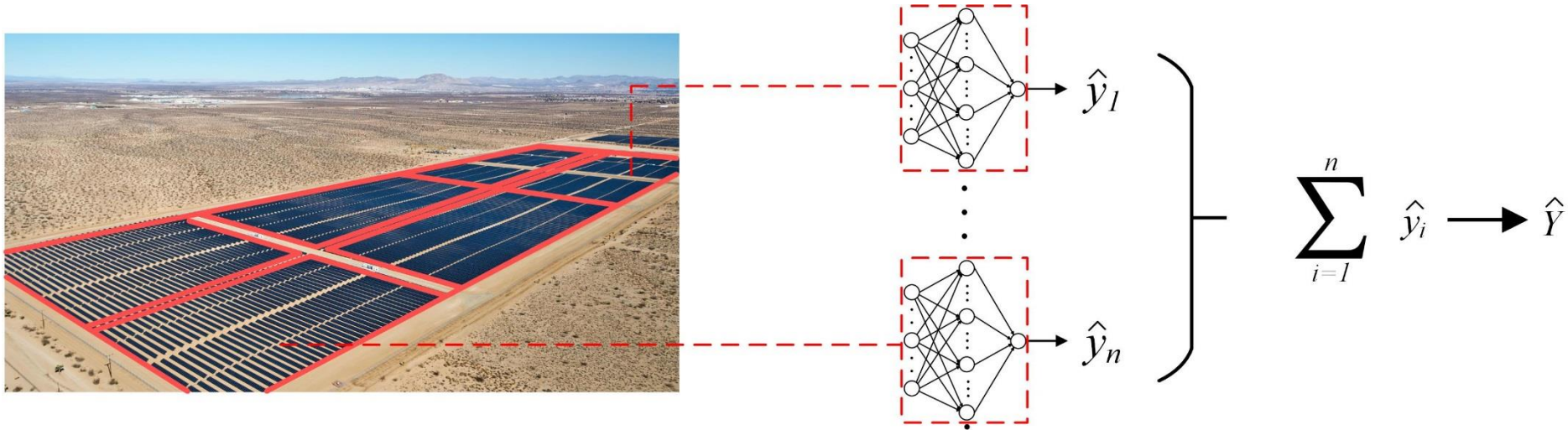
- Hypothesis: Disregards important micro-level information

Proposed research

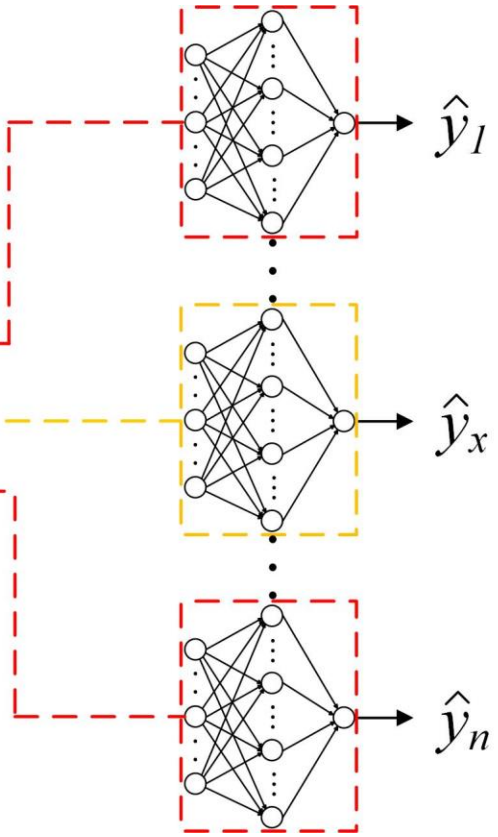


Proposed research

- Forecasting model applied to inverter blocks

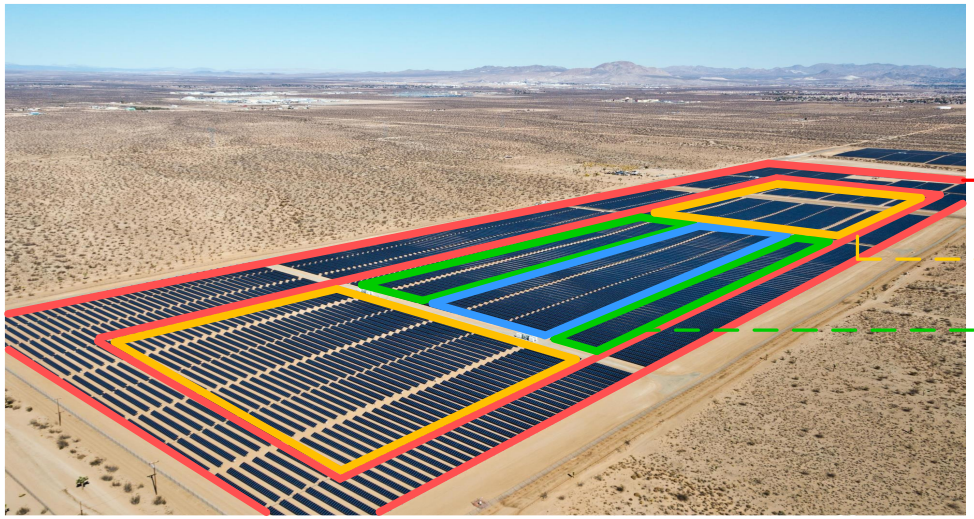


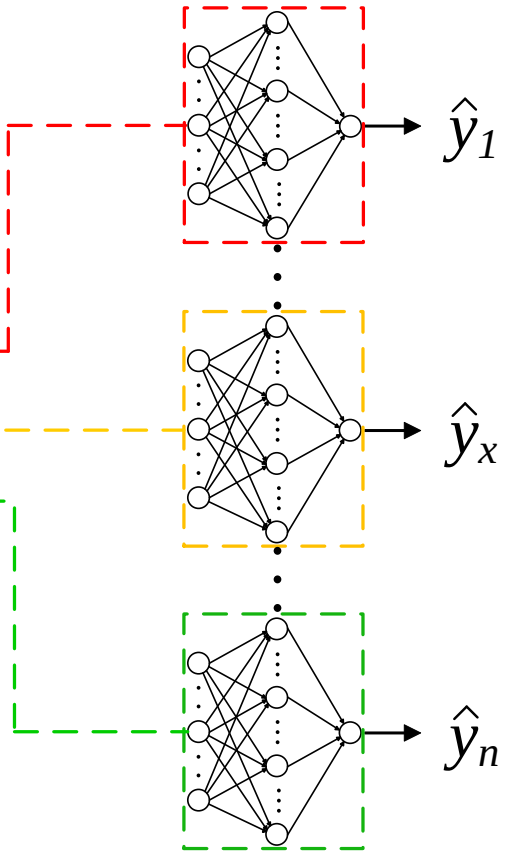
Proposed research



- PV module string-level approach
- Forecasting models developed for individual PV module strings
- Problem…~ 13,000 strings = 13,000 models

Proposed research

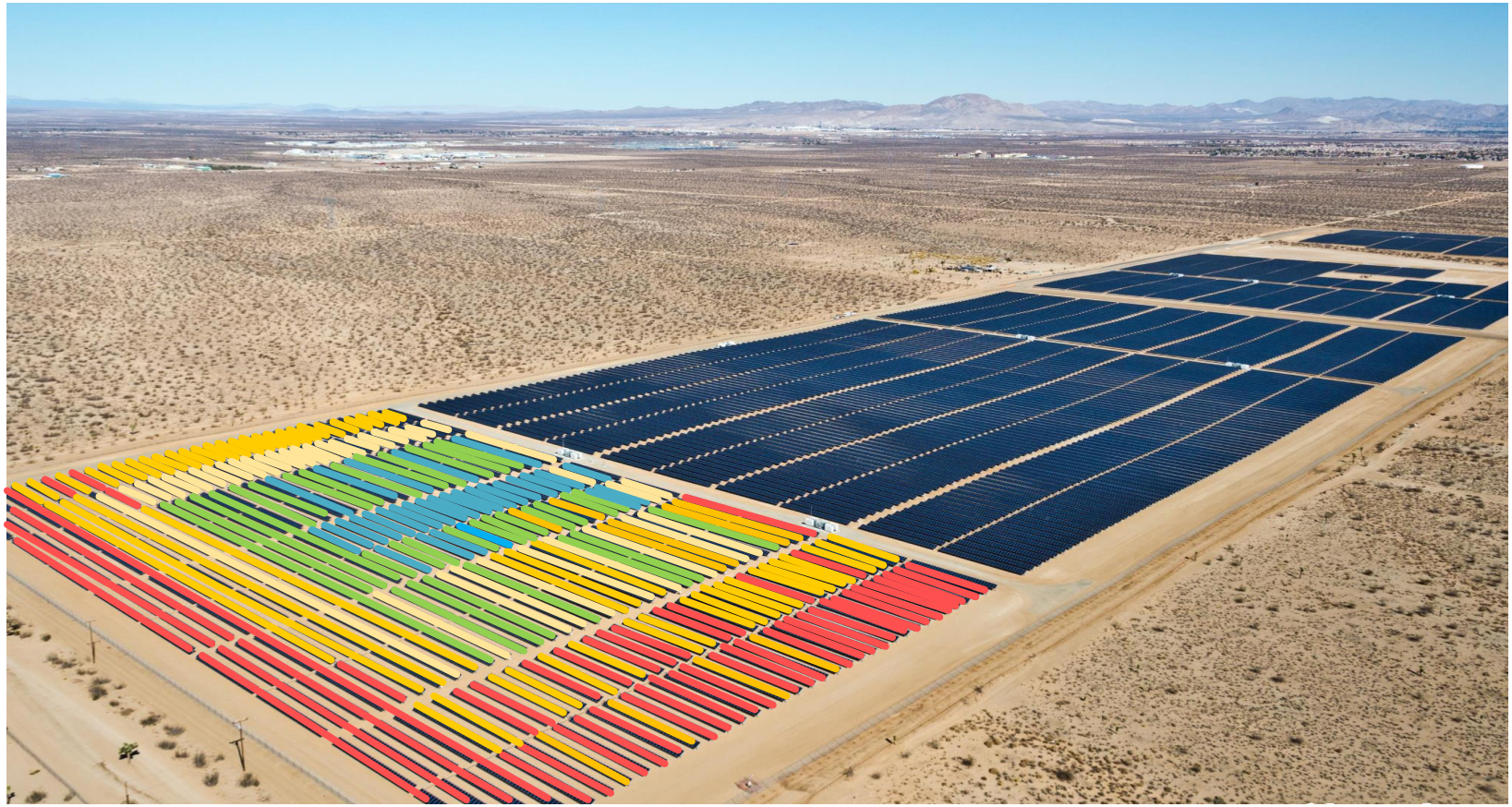




- Segmented PV forecasting approach
- Forecasting model applied to individual segments
- Delivers a forecast which accounts for micro level info

Develop PV Segmentation algorithm

- How will segments be allocated ?
- Segments allocated based on module strings with similar performance
- Use image-segmentation techniques to establish permanent segments



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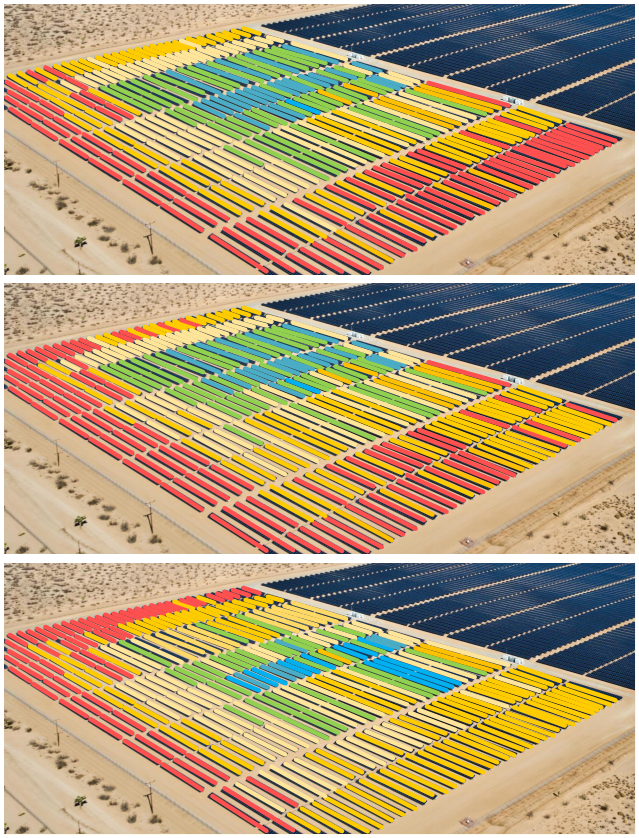

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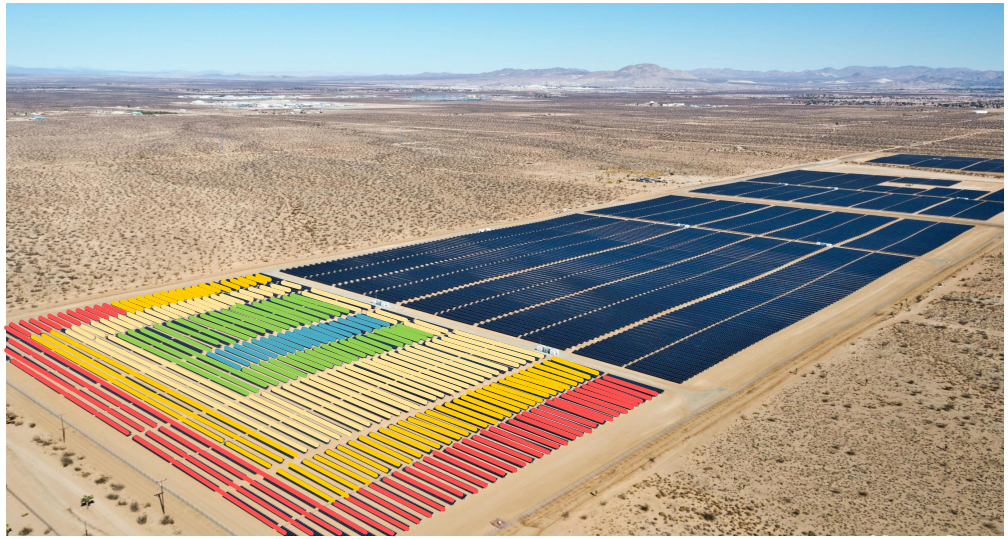

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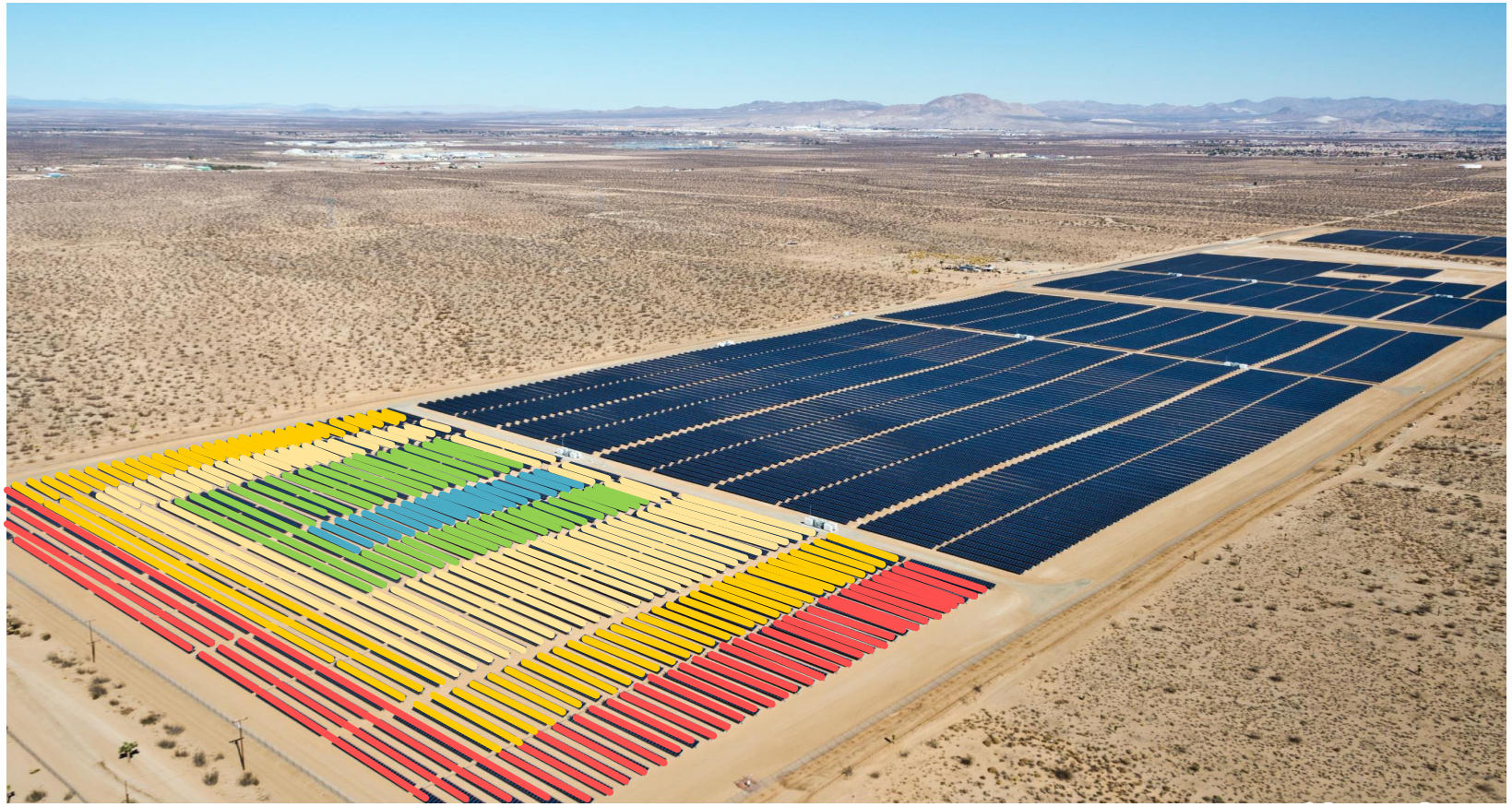
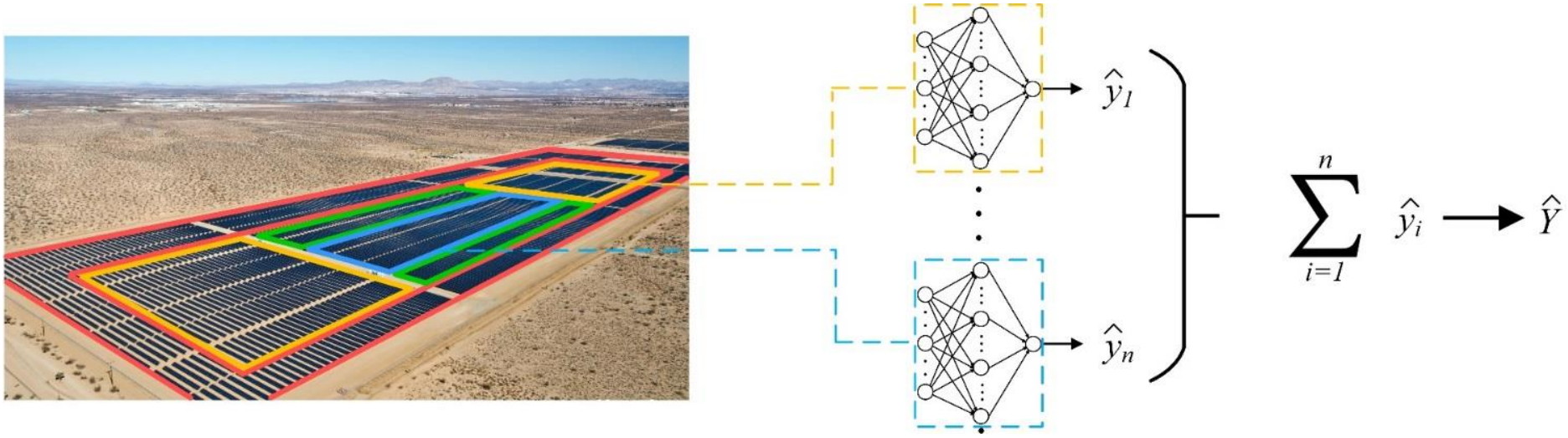


Aggregated forecast



My work

- Use Deep-NN and/or other ML-based models
- Perform real world forecast
  - 1h, 3h and 6h intervals
- Training Input variables
  - 3 years historic PV power data (string level, inverter level, grid connection)
  - On-site measurements:
    - Irradiance, Temp. (module, ambient) Wind speed & direction, Rainfall
- Forecast Input variables
  - Weather data obtained from NWP models

End