



# Extending Fleet Forecasting Capability into the Probabilistic Realm

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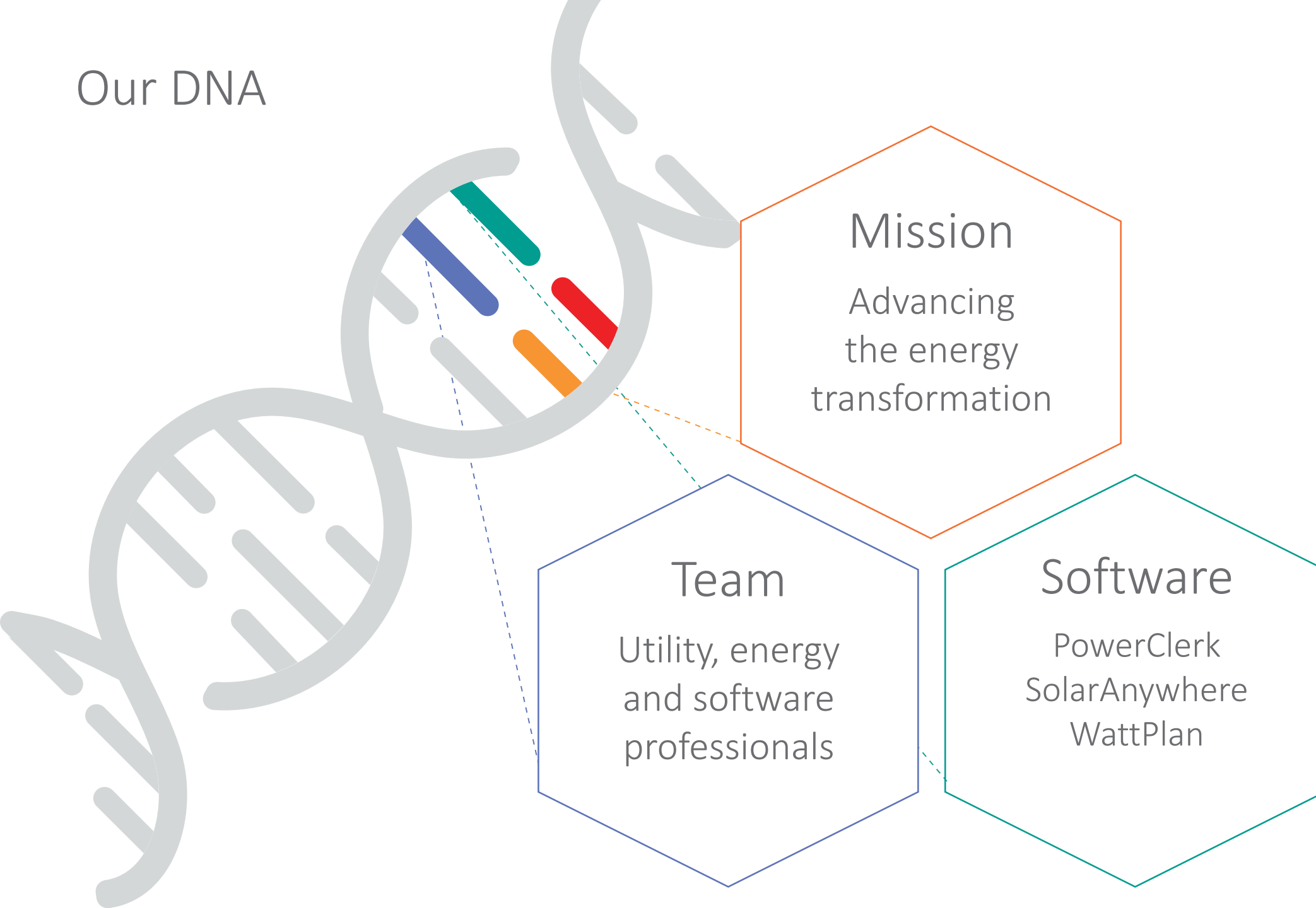
ESIG, Applying Meteorology in Power Systems

June 19, 2018

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# Our DNA



## What Issue is CPR Addressing?

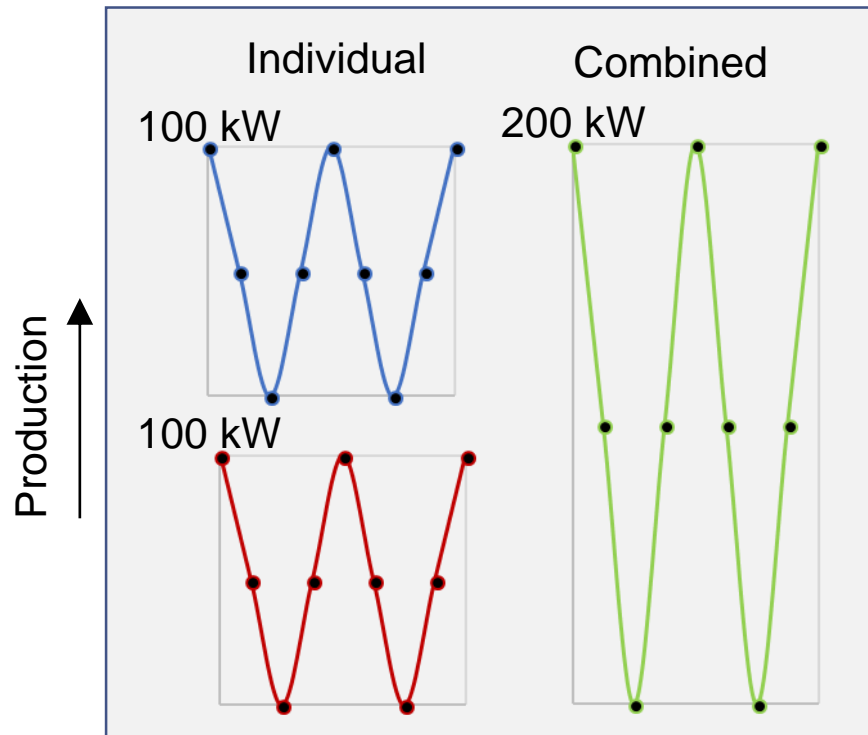
- PV fleet simulation introduces an issue that individual plant simulations do not encounter
- Due to fixed solar resource resolution, nearby plants must share the same irradiance input data when simulating forecasted output
- This may lead to an overestimate of inter-plant correlation and an artificially high variability of the aggregated fleet

*How can one address this issue when irradiance data limitations exist?*

# What is Correlation?

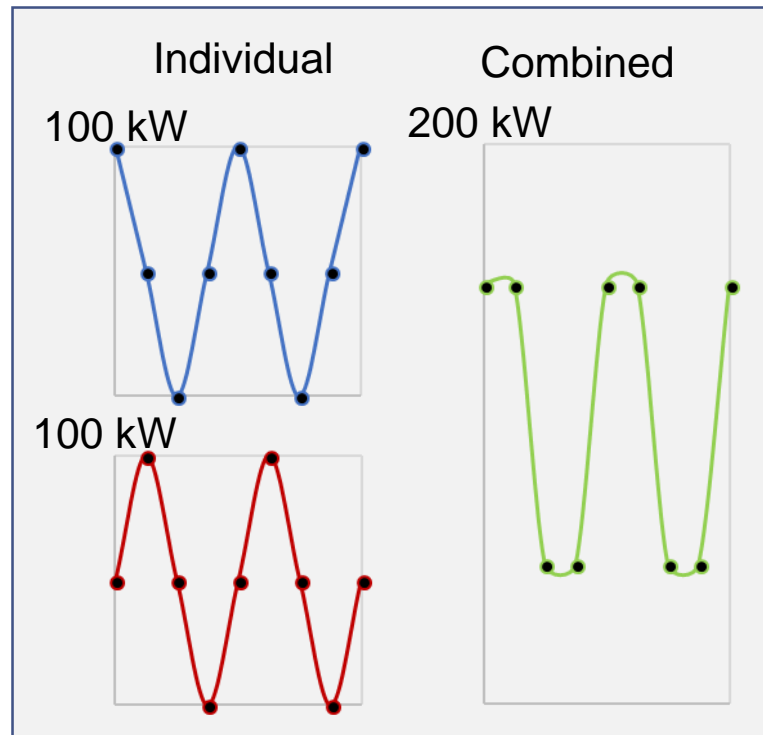
Scenario 1

**100% Correlation Coefficient**



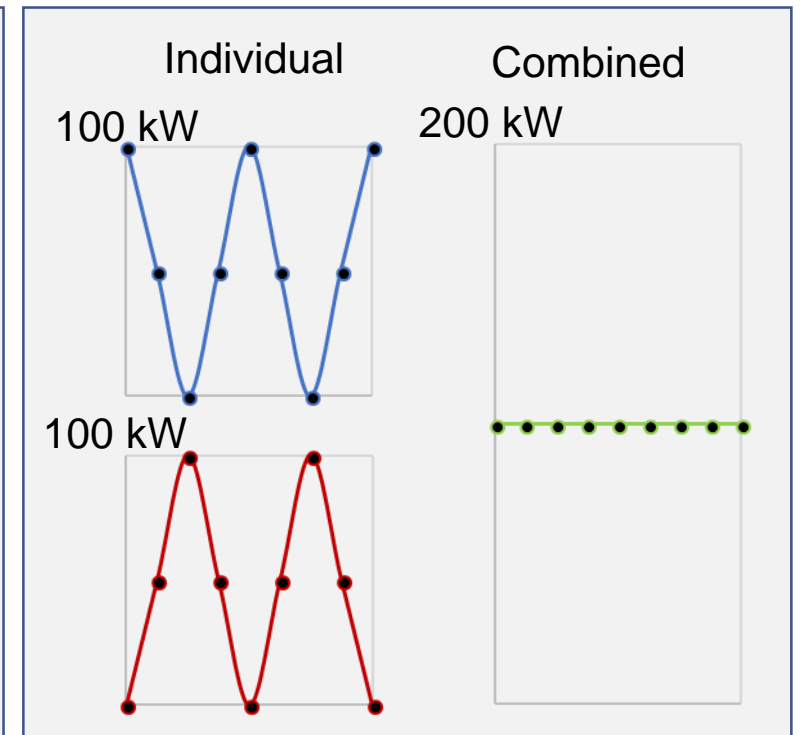
Scenario 2

**0% Correlation Coefficient**

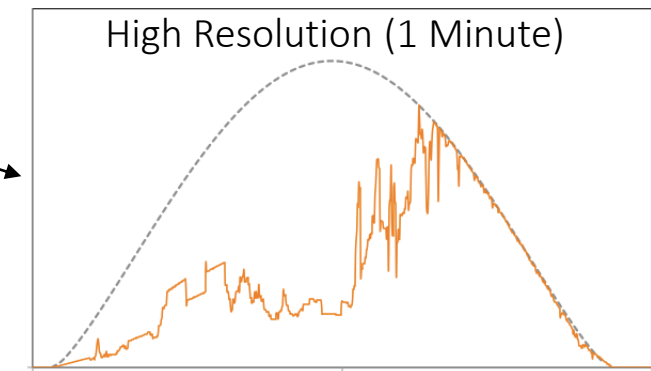
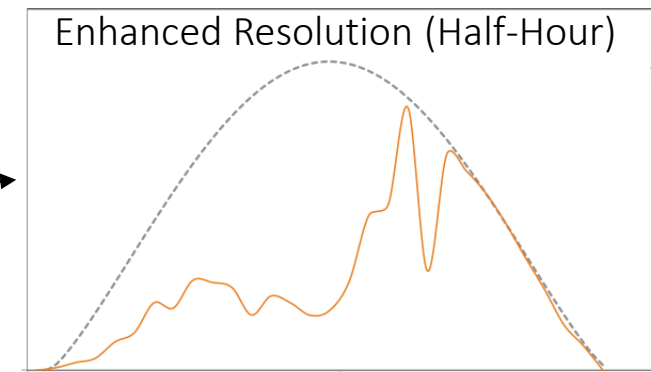
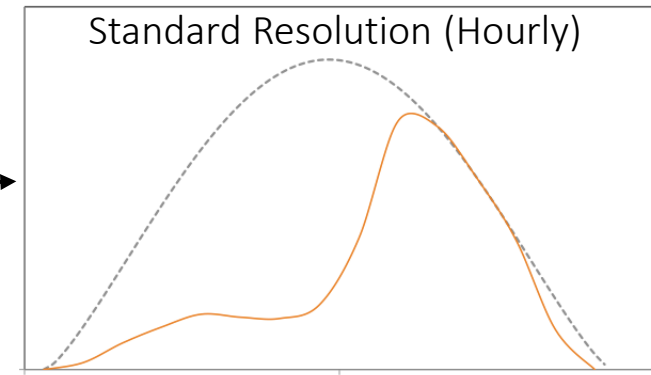
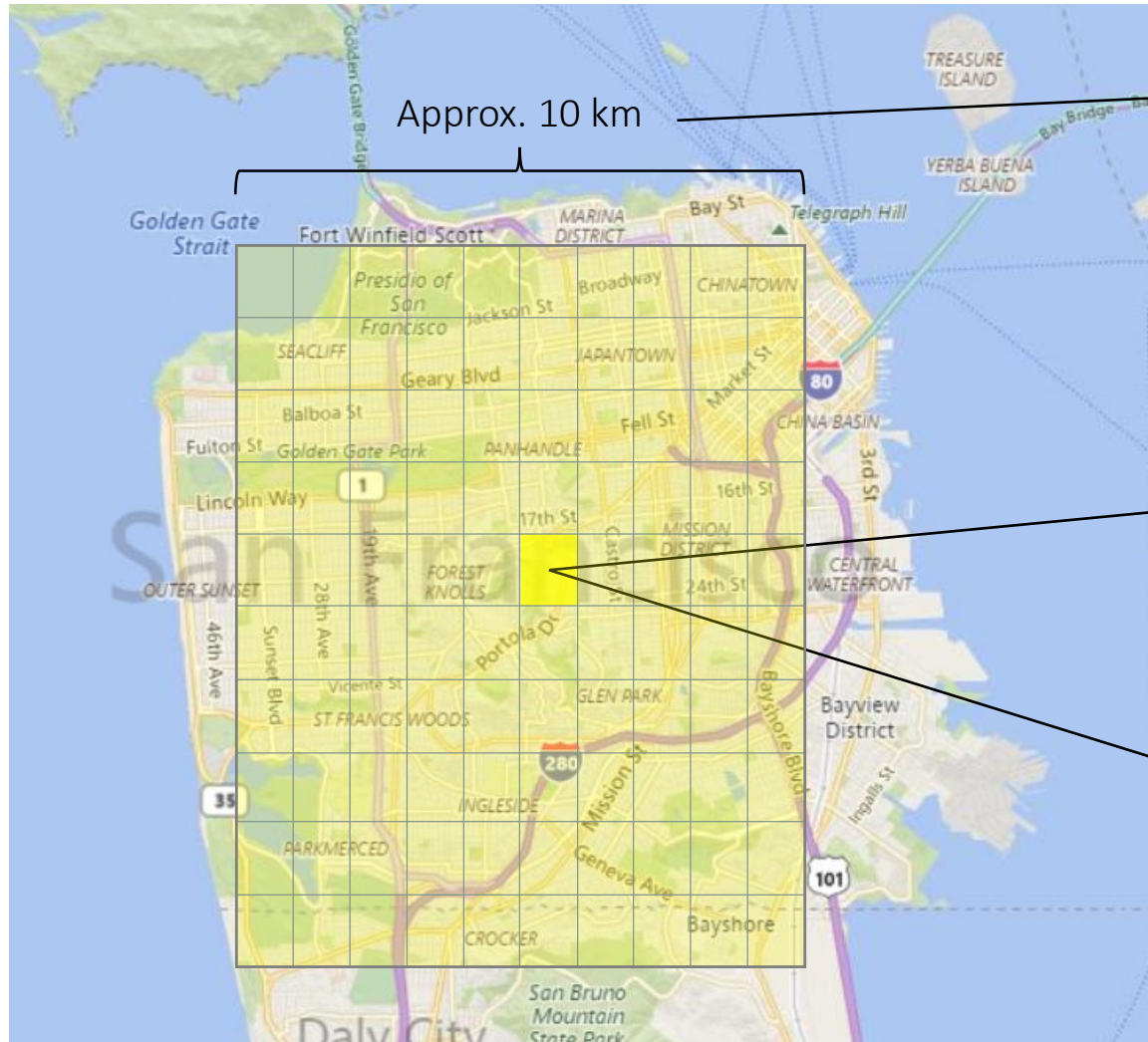


Scenario 3

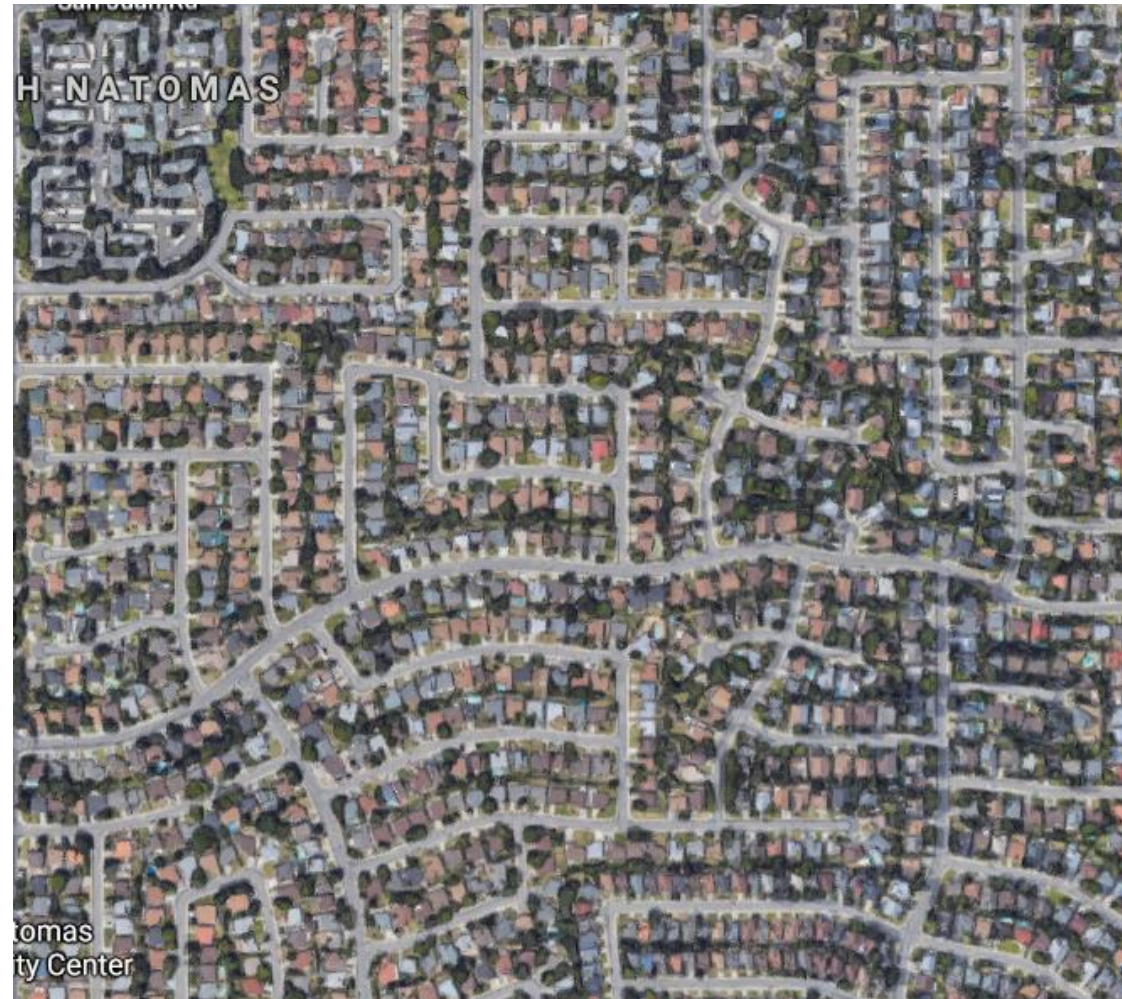
**-100% Correlation Coefficient**



# SolarAnywhere Data Resolutions



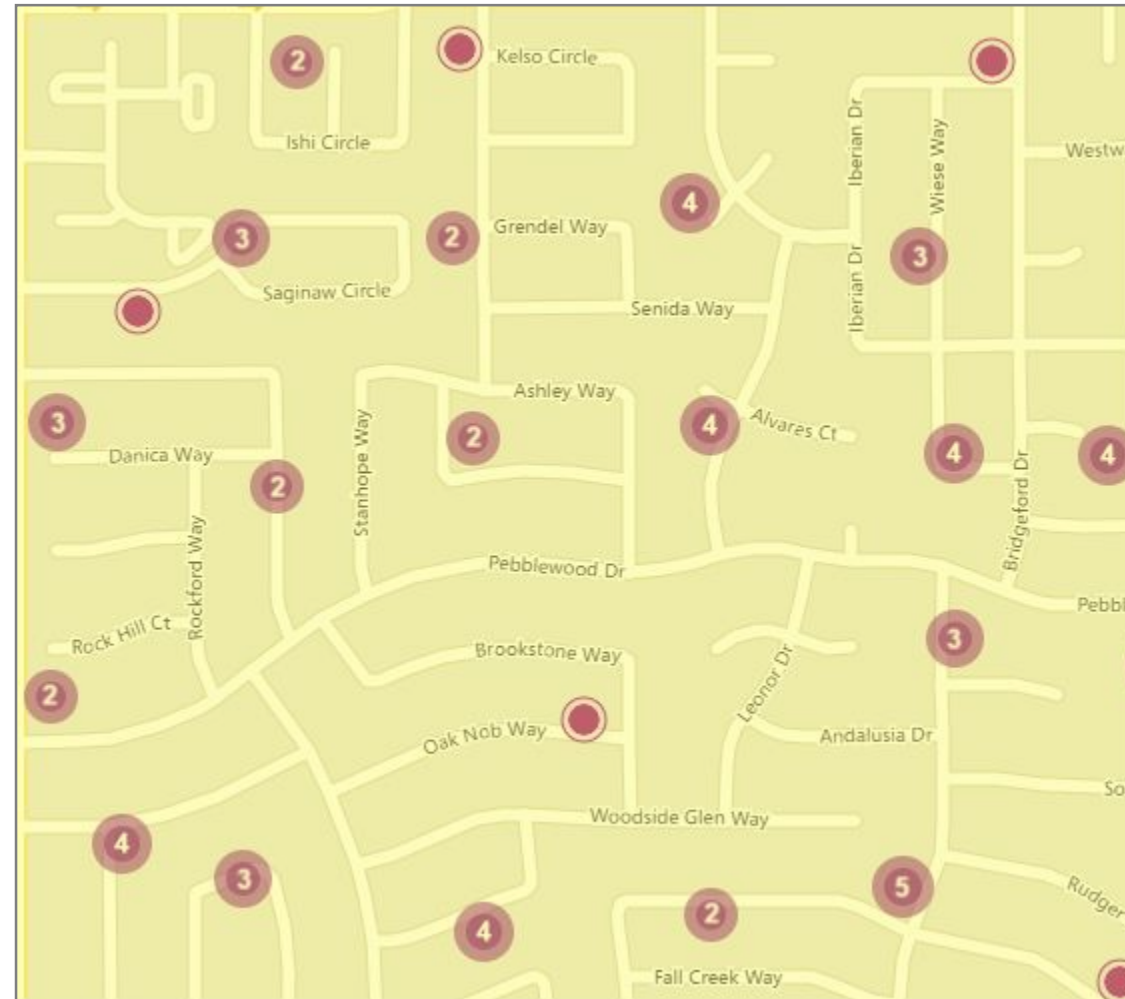
# Consider Situation at Distribution Feeder Level



Source:

<https://www.google.com/maps/place/Sacramento,+CA/@38.6214829,-121.496456,15z>

# There are Many PV Systems and One Irradiance Observation

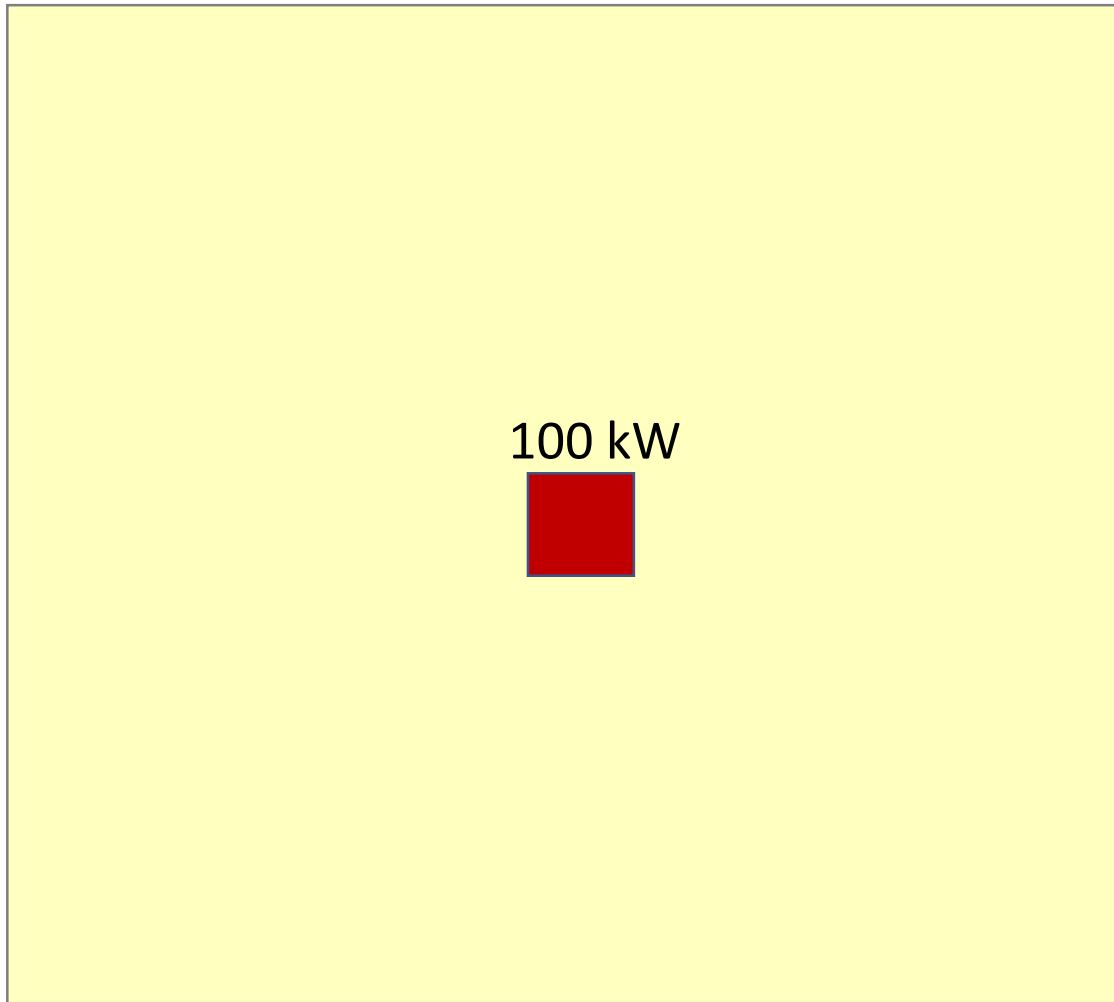


Circles represent number of PV systems on surrounding homes

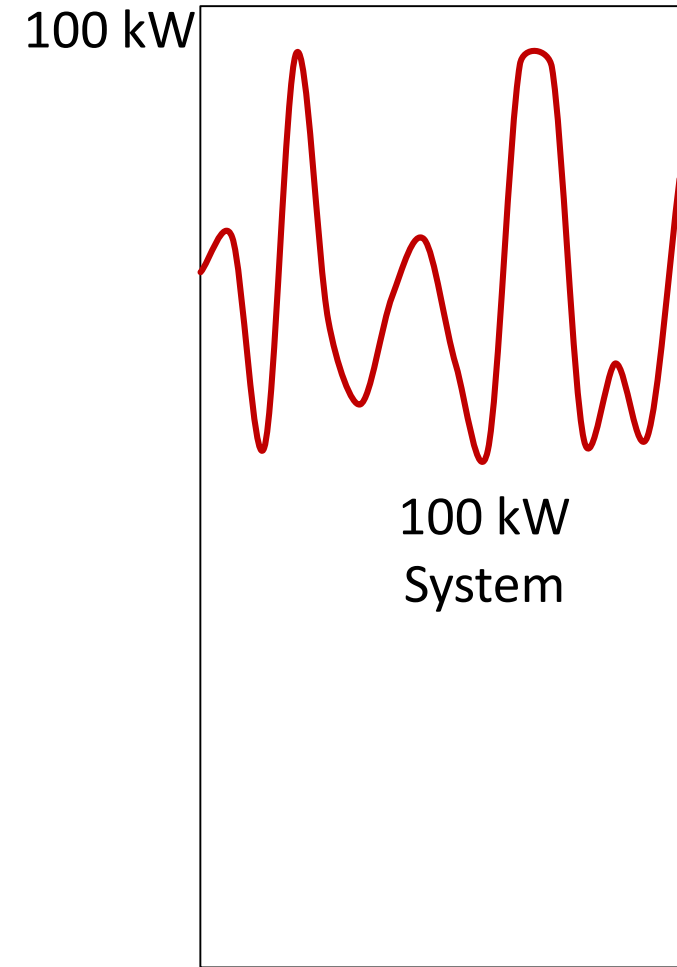
One - 1 km irradiance grid tile for 50+ PV systems

Source:  
<https://smud.wattplan.com>

# Output Variability is Higher for 1 - 100 kW System ...



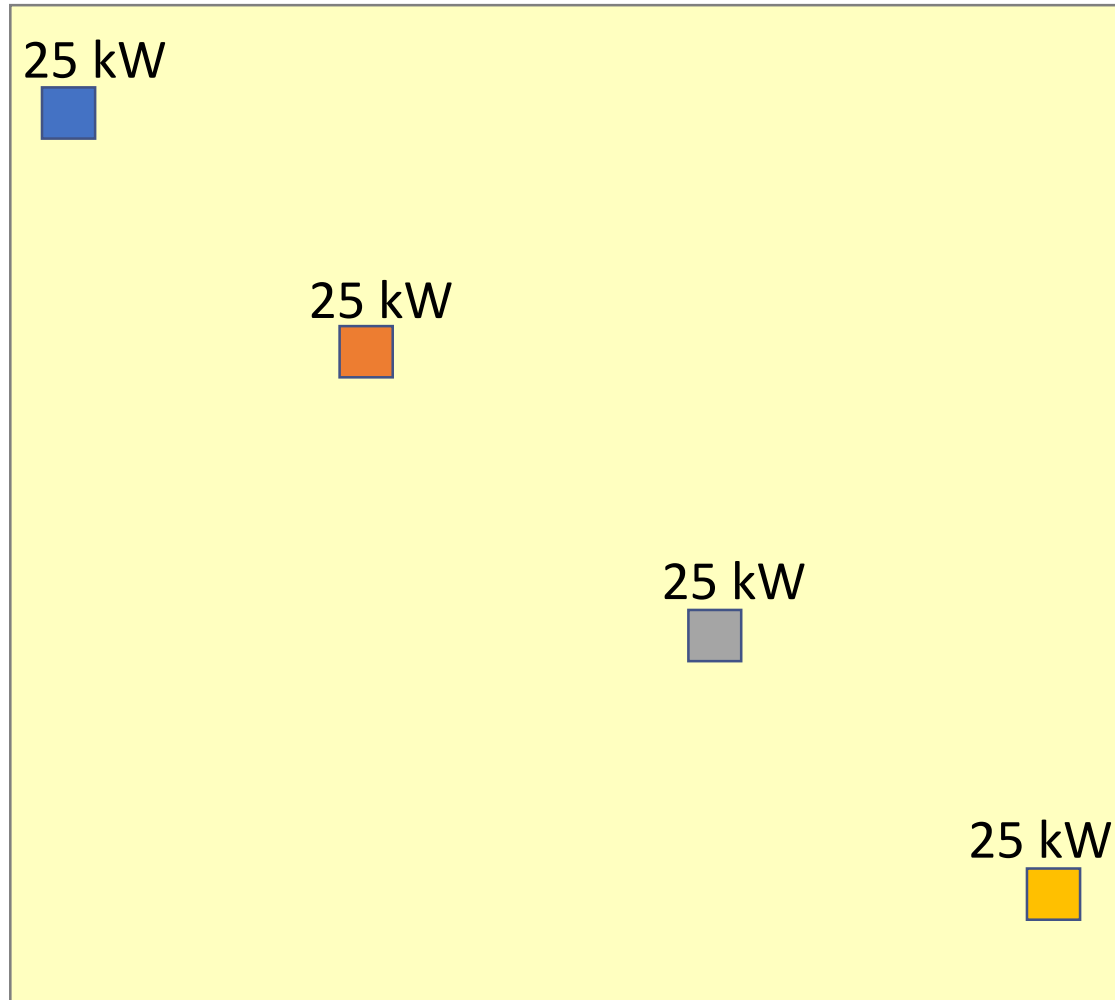
1 km Grid Tile



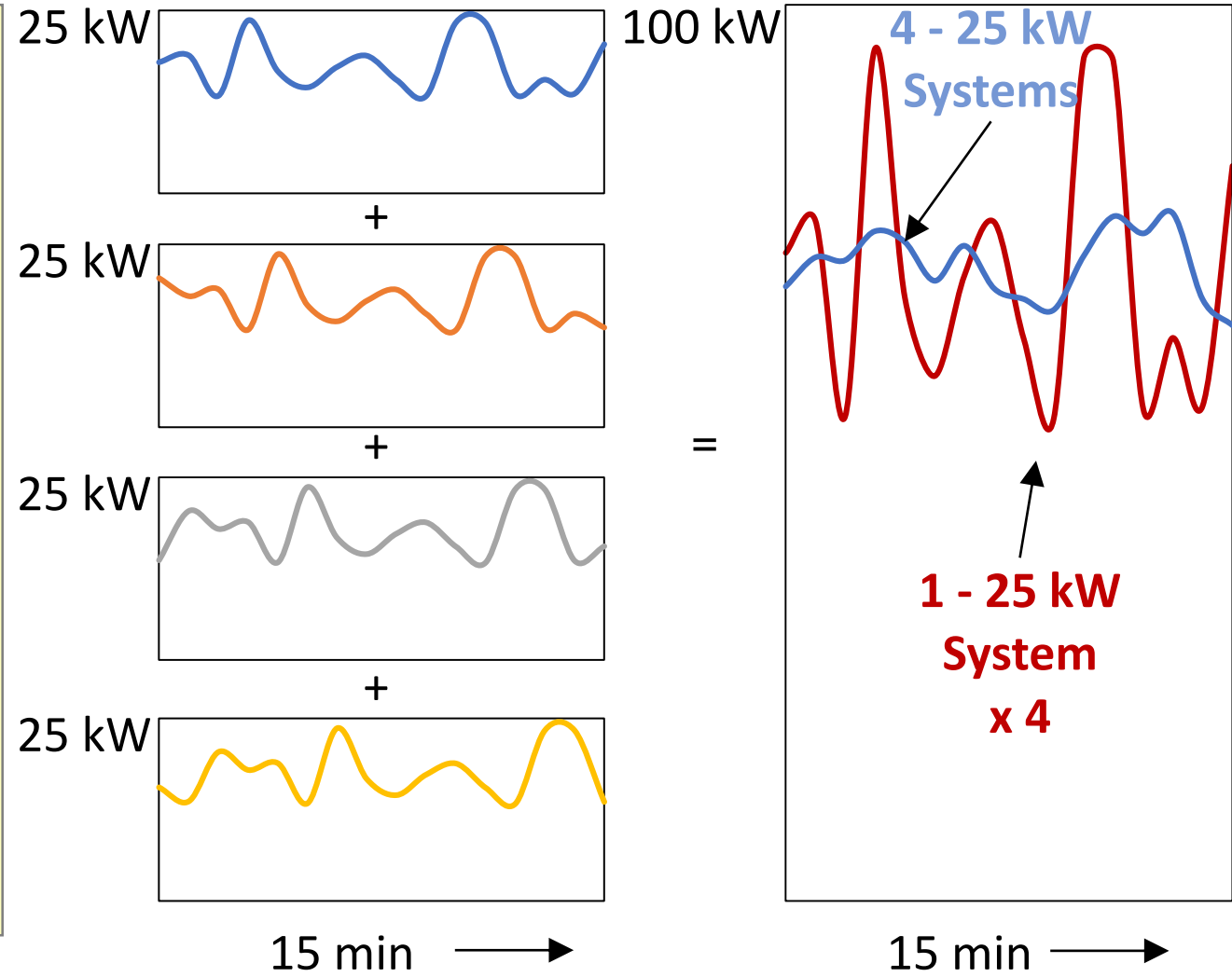
15 min →



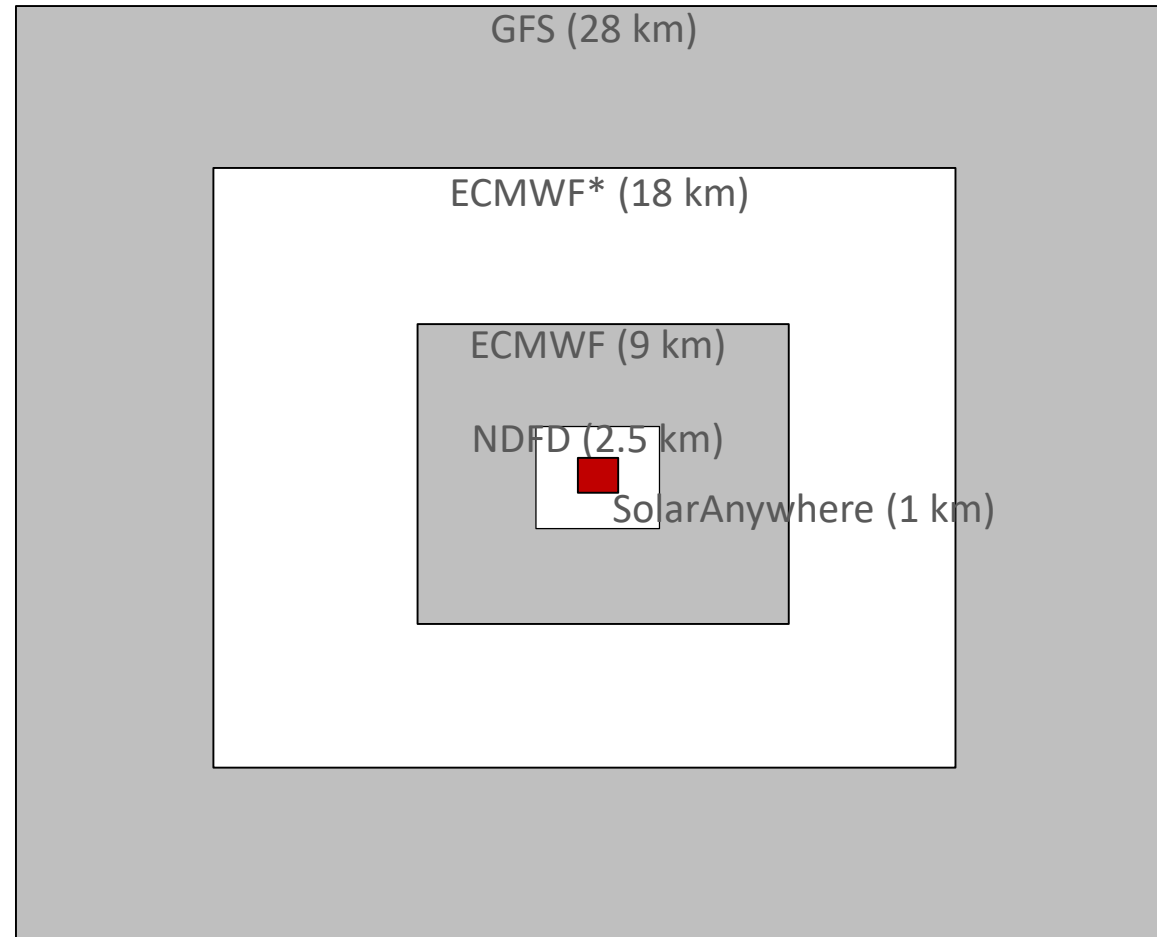
... than for 4 - 25 kW Systems



1 km Grid Tile



# Irradiance Resolution is Not Only a Distribution Level Issue



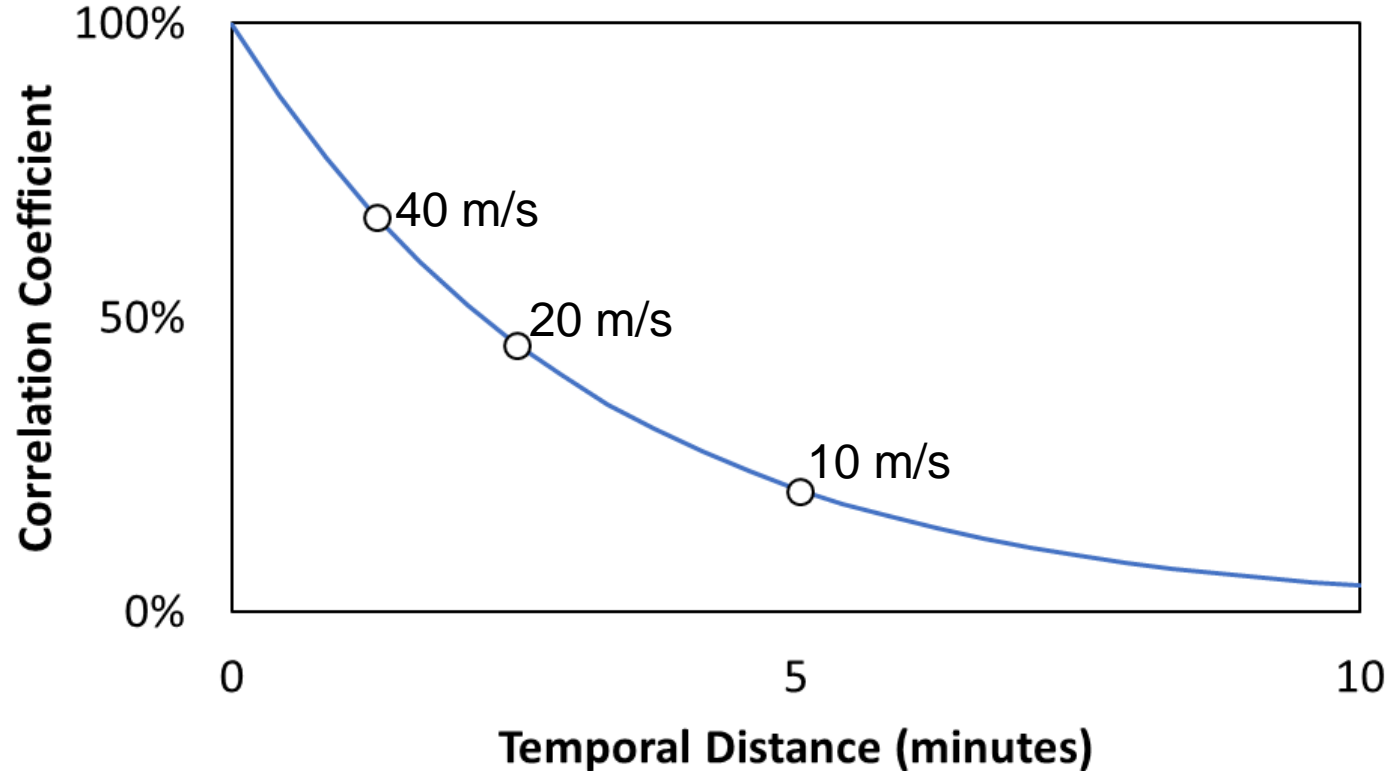
These are key data sources that commercial providers use

# How to Address this Problem

- ✓ Divide forecast of PV systems into two parts:
  - Forecasted production under ideal "clear sky" conditions
  - Modulating effect of local sky/cloud conditions
- ✓ Calculate clear-sky fleet output based on:
  - Individual system ratings
  - Individual system sun position
- ✓ Calculate PV fleet correlation coefficient based on:
  - Distance between systems
  - Cloud speed
- ✓ Combine clear-sky fleet output and fleet correlation with effect of clouds
- ✓ Probabilistically simulate PV production

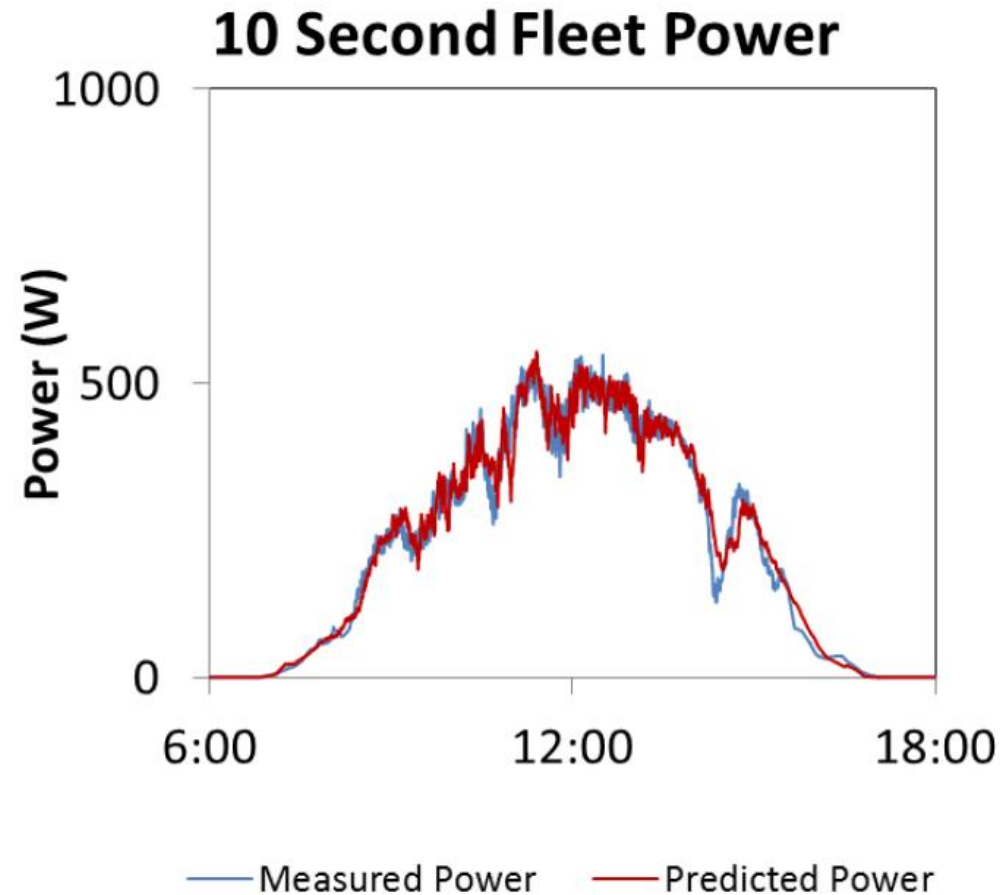
# Output Correlation Between PV Systems is Predictable

***PV systems are 3 km apart***



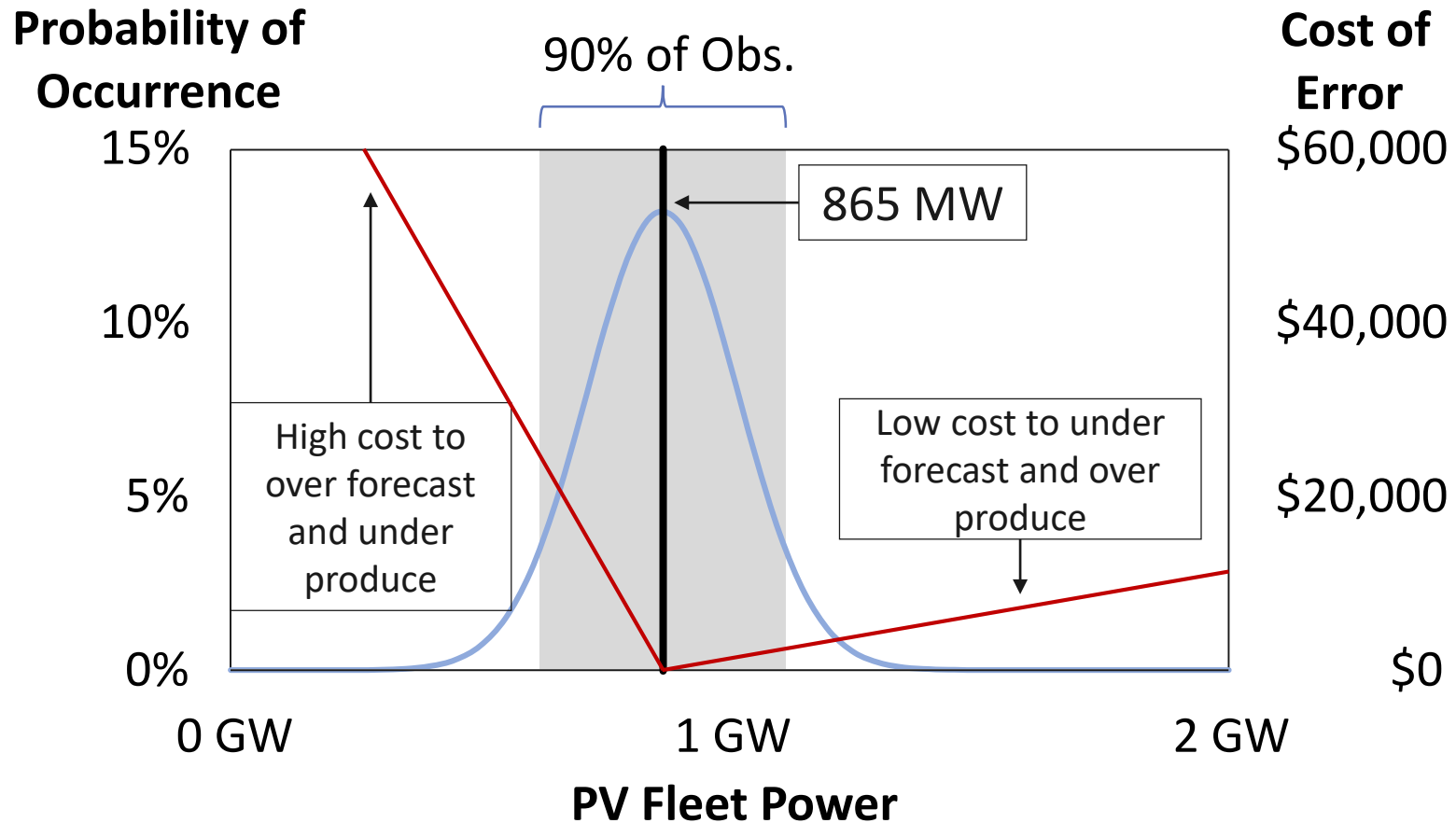
Temporal Distance @ 10 m/s  
= (3,000 m) / (10 m/s) = 300 s

# Probabilistically Simulate PV Fleet Power



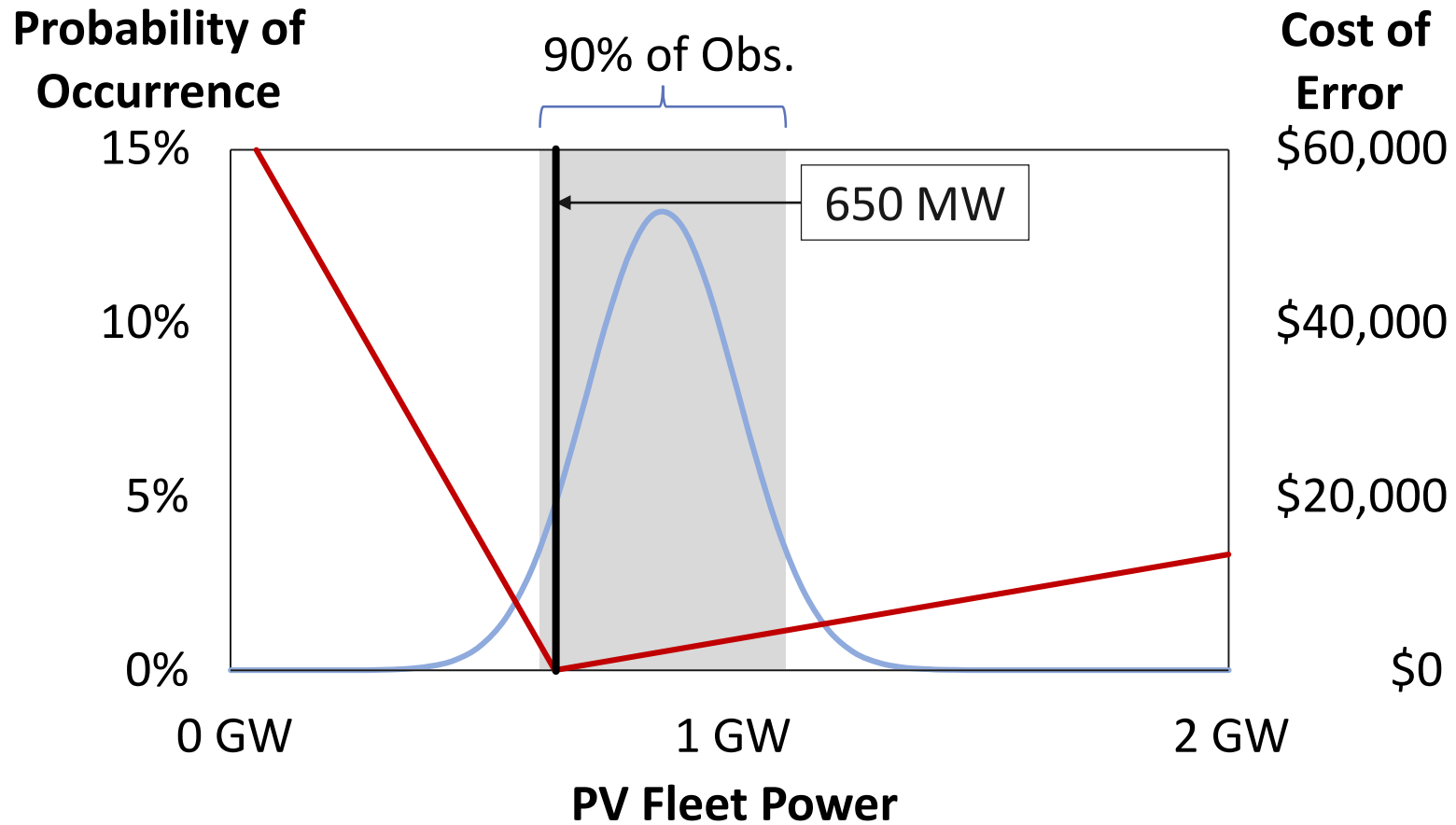
# Expected Forecast for 1 hour

**Expected Error Cost: \$6,600**



# Risk-Adjusted Forecast: Reduces Error Cost by 60%

***Expected Error Cost: \$2,700***



# Conclusions

- PV fleet simulation introduces an issue that individual plant simulations do not encounter
- Fleet forecasts may reflect artificially high correlation (higher fleet variability) when plants share same solar resource data
- CPR has developed an approach that addresses this issue



Thank you



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