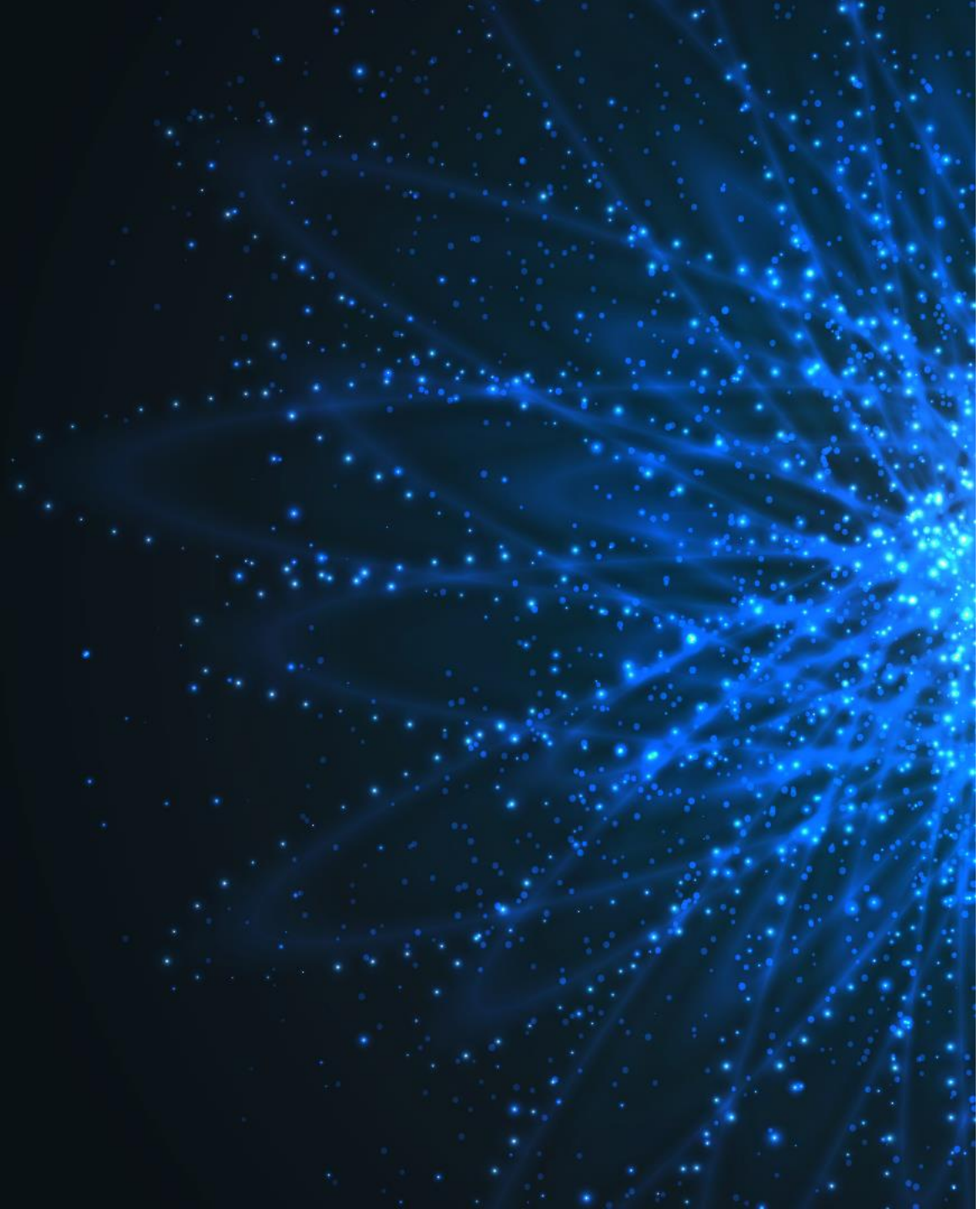

1-Minute Forecasts for Distributed Solar/Storage Applications (DERMS)

Agata Swierc

Technical Product Manager

June 20, 2018

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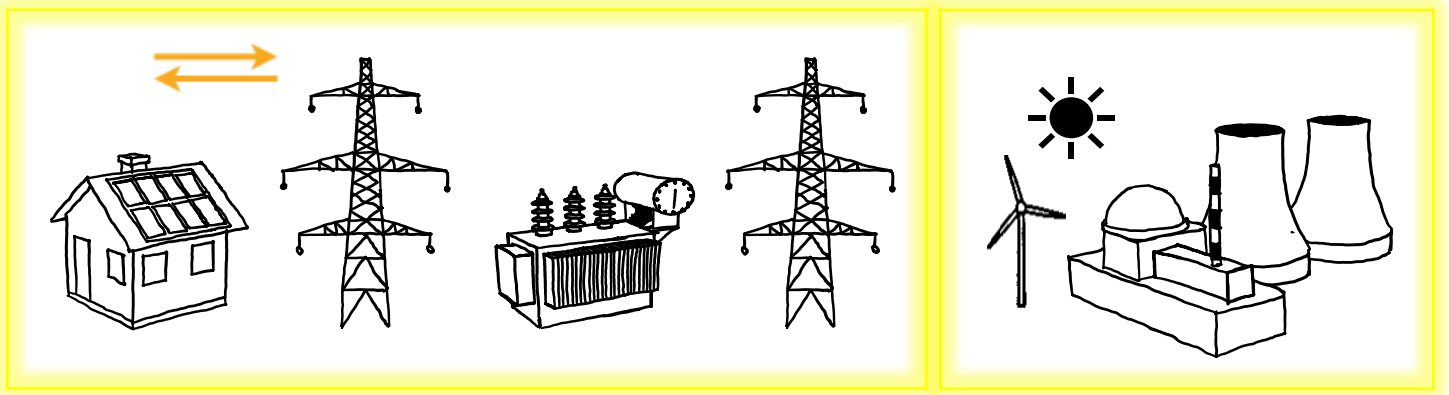
Utility Processes and Systems Impacted by Solar PV



PROCESSES		SYSTEMS			
		Sub-circuit	Feeder	Substation	Balancing Area
Planning	Long-term		DISTRIBUTION PLANNING		IRP
Planning	Short-term	INTERCONNECTION / HOSTING CAPACITY			
Forecast	Now	CIRCUIT-SWITCHING / DERMS			
Forecast	Hourly		ADMS		
Forecast	Day-ahead			EMS / ENERGY MARKETS	

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Agenda

- The Challenges Created By Behind-the-Meter (BTM) PV
  - Utility-Scale v. BTM PV
  - EPRI Project
- Distributed Solar/Storage Applications (DERMS)
  - Battery Lifetime
  - Two-Level Control Strategy
  - 1-Minute Forecast Application
- Case Study
  - Project Objectives
  - Preliminary Results

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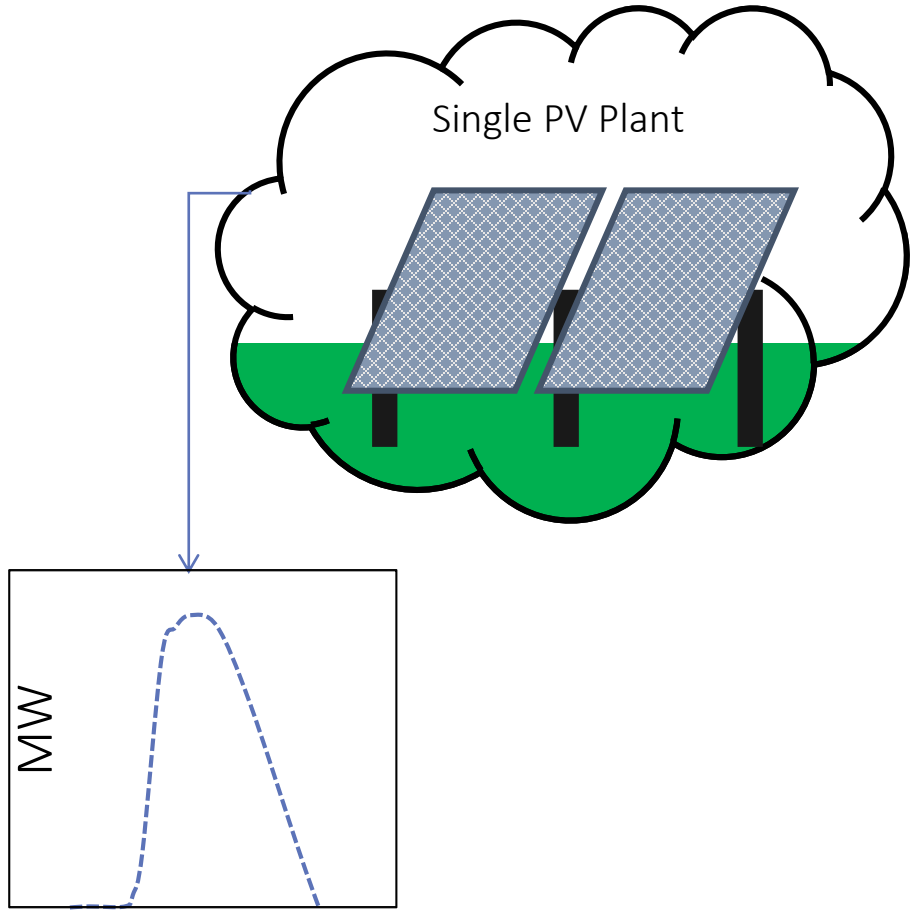
Single Utility Plant

- Typically >MW scale
- $1,000s in operations budget per site
- Revenue loss justifies cost of plant-level forecasting
- Employees on site



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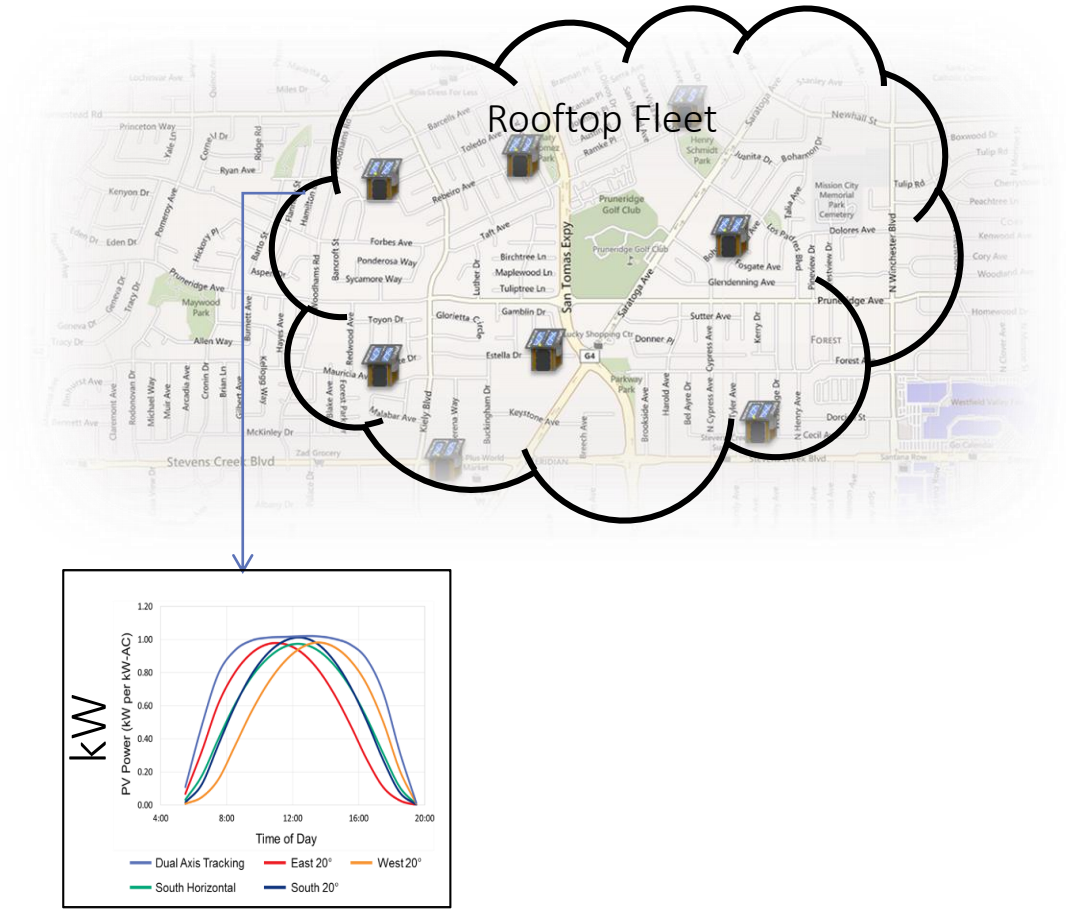
Behind-the-Meter (BTM) PV

- Individual sites typically kWs
- $10s in operations budget per site
- Single site impact on grid small, but large when aggregated
- Customers on site



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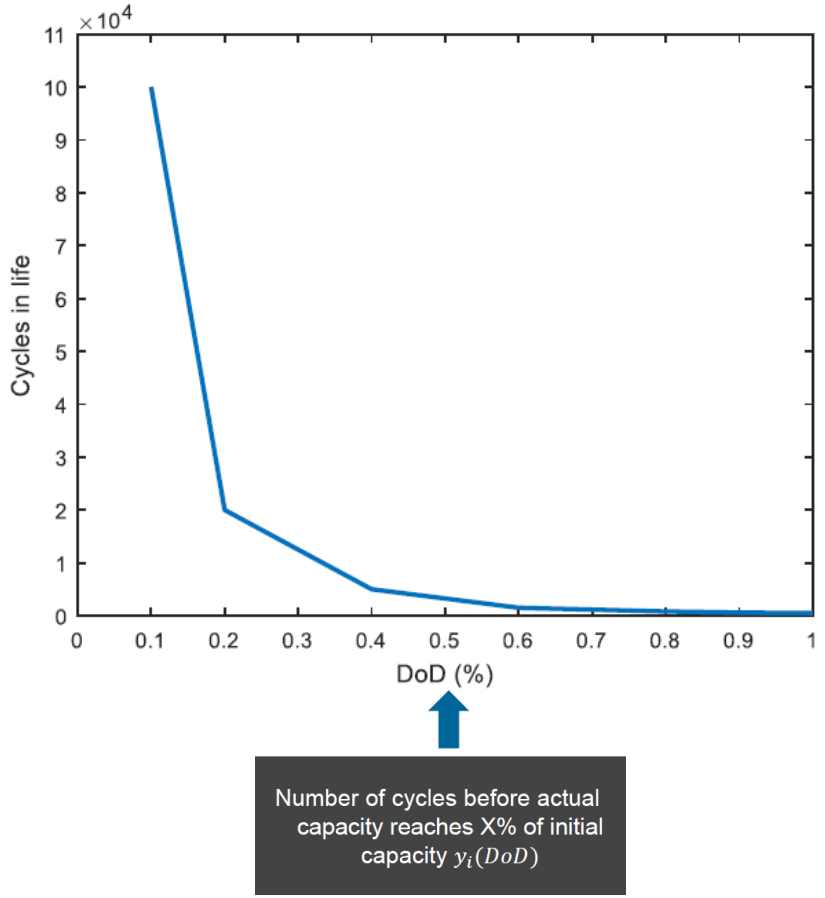
Key Goals

- Mitigate potential adversarial DER impacts on distribution system
  - ① Limit impact of PV ramp events
  - ② Limit active power demand

- Support economic objectives of DER owner
  - ③ Energy & demand charge optimization behind-the-meter
  - ④ Battery degradation management

④ Battery degradation management

- Battery degradation function of:
  - number of cycles
  - Depth of Discharge (DoD)
- Cycles + high DoD =
  - faster aging
  - lower economic value of storage
- Controllable loads can help reduce battery cycling
- Forecast can predict ramp events and enable better control strategy



Source: EPRI SHINES – February 2018

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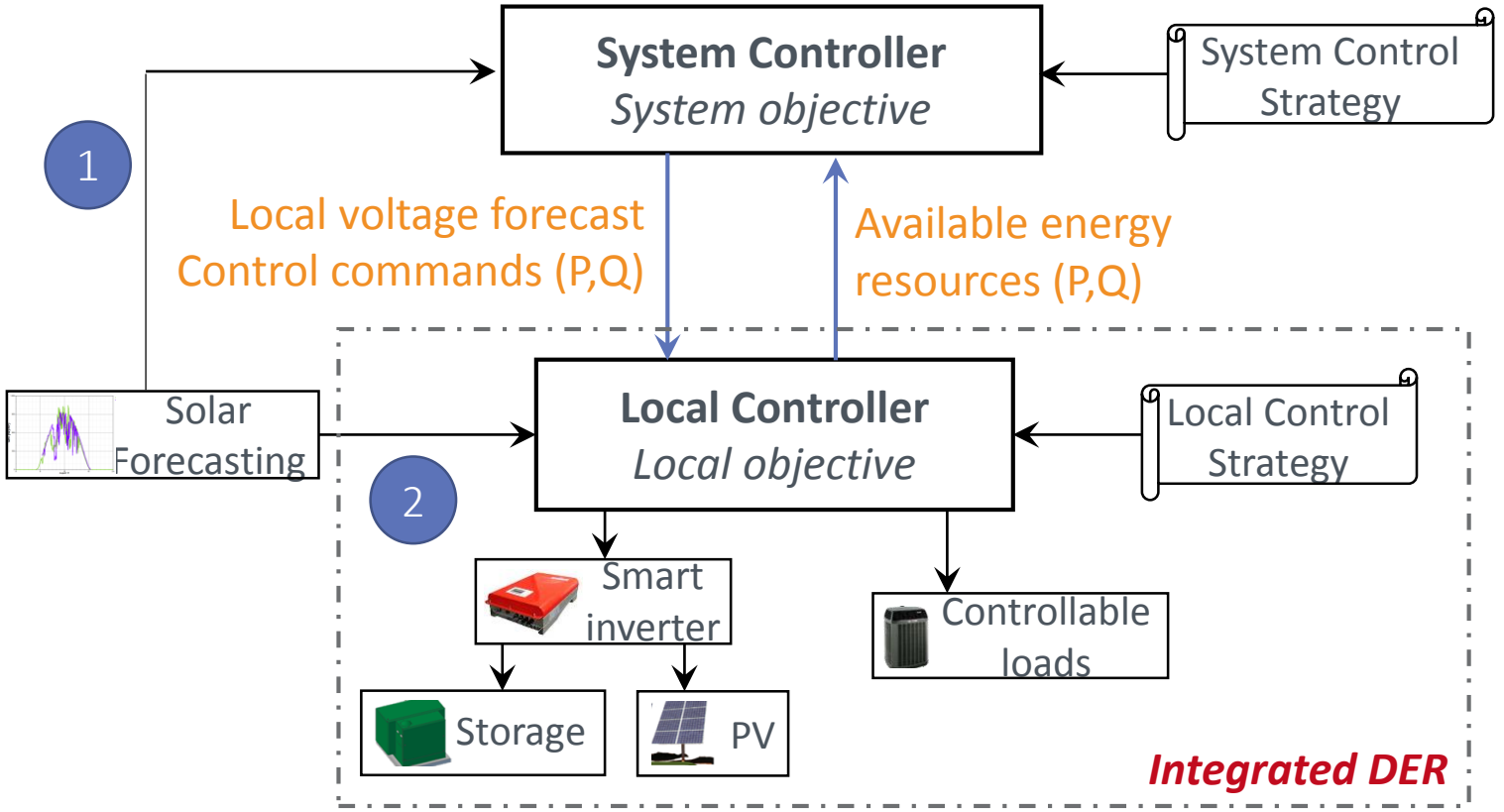
DERMS Two-Level Control Strategy

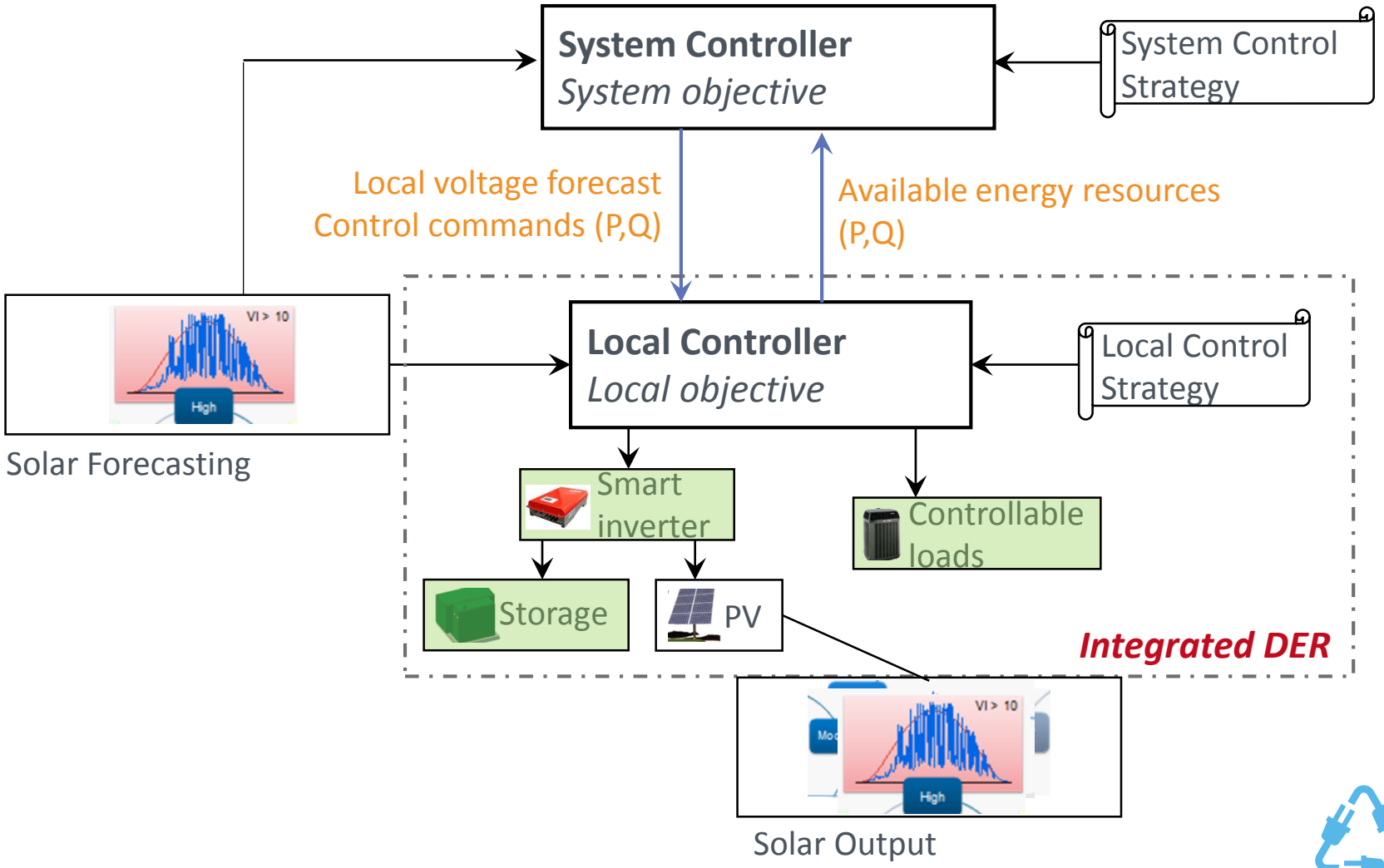
EPRI ELECTRIC POWER RESEARCH INSTITUTE



Execution Approach

Solution Design	Systems Design & Implementation	Site Demonstrations	Performance Assessment & Impact Analysis
- Control architecture - Functional requirements - Performance metrics	- Local & system controllers - Smart inverter design & development - Improved solar forecasting module	- Site preparations - PV & ESS Commission - Data collection	- Solution technical performance - Impact on PV hosting capacity - Cost & benefit analysis

DERMS Forecast Application



Source: EPRI SHINES Kickoff – June 2016

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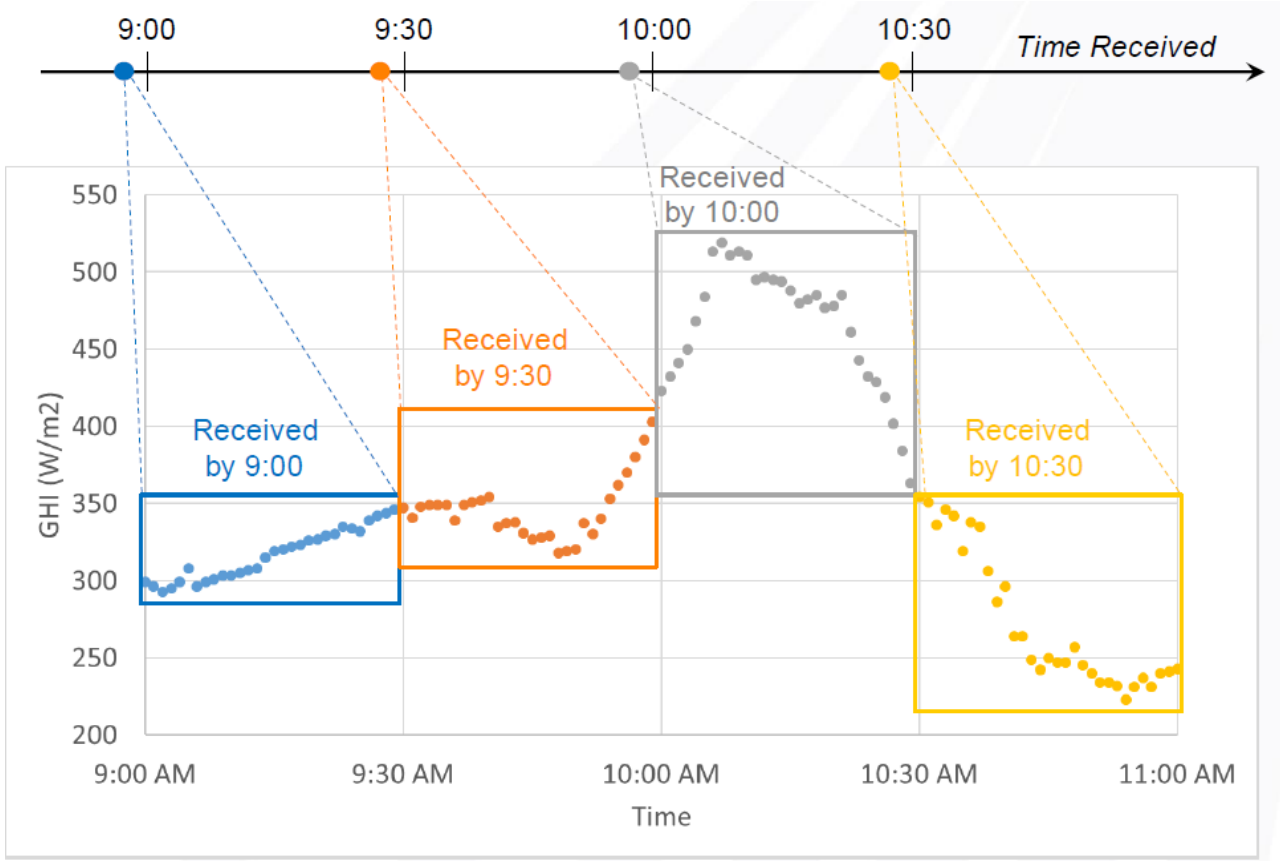
DERMS Solar Forecast Delivery

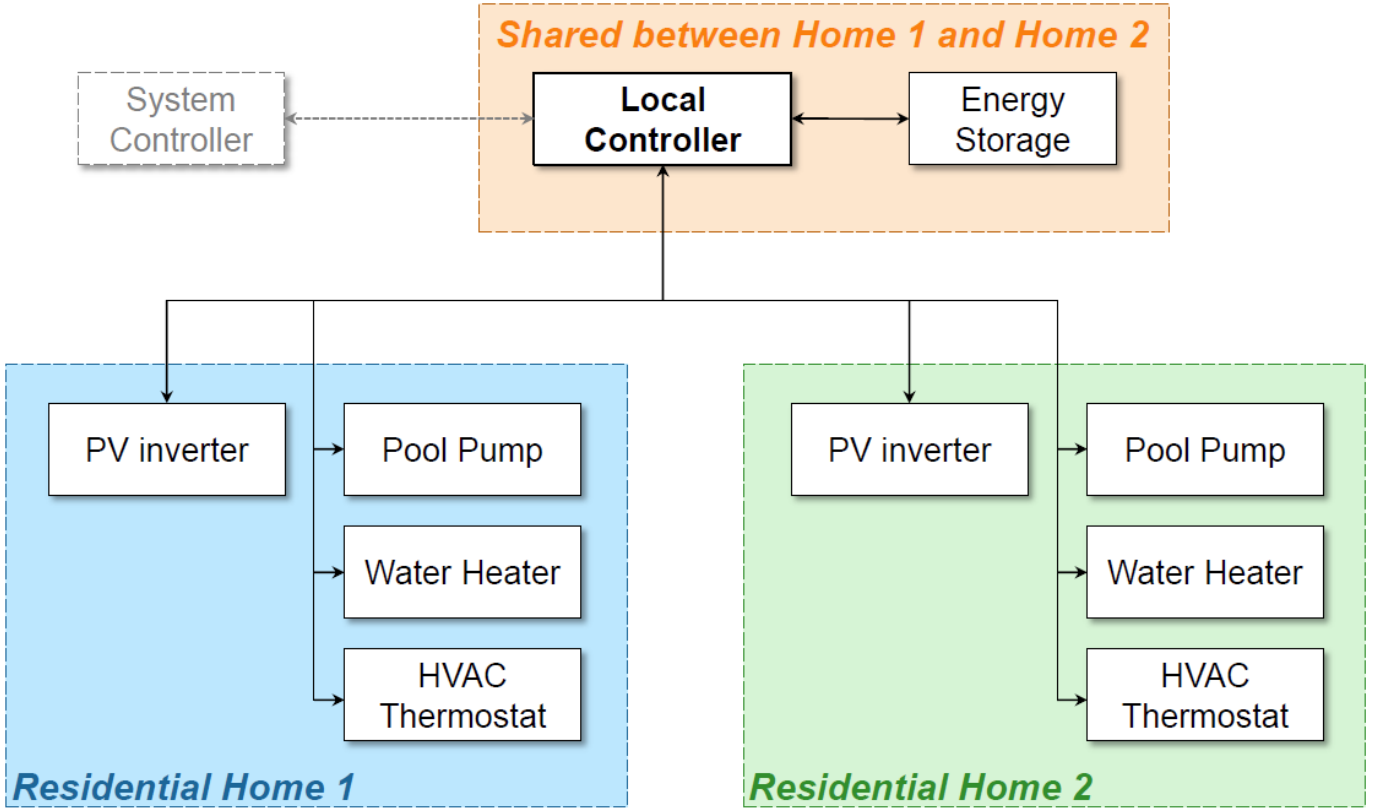
- System Controller
  - 1-km spatial
  - 30-min temporal
  - 7-day ahead
- Local Controller
  - 1-km spatial
  - 1-min temporal
  - 30-min ahead



DERMS Case Study

Photo Credit: Gulf Power

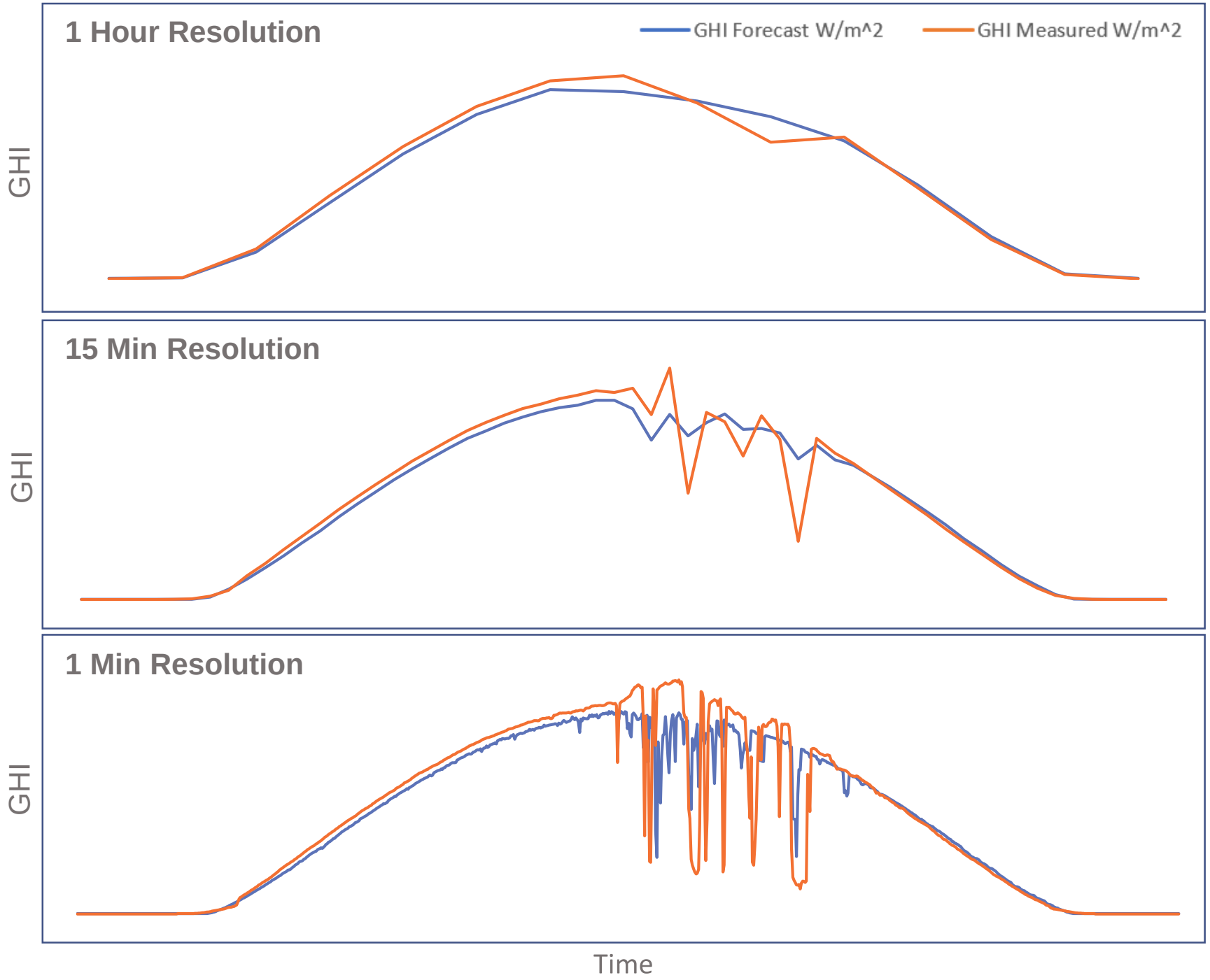
Configuration of Residential Demonstration Site
Control Diagram



Source: EPRI SHINES – February 2018

Single day

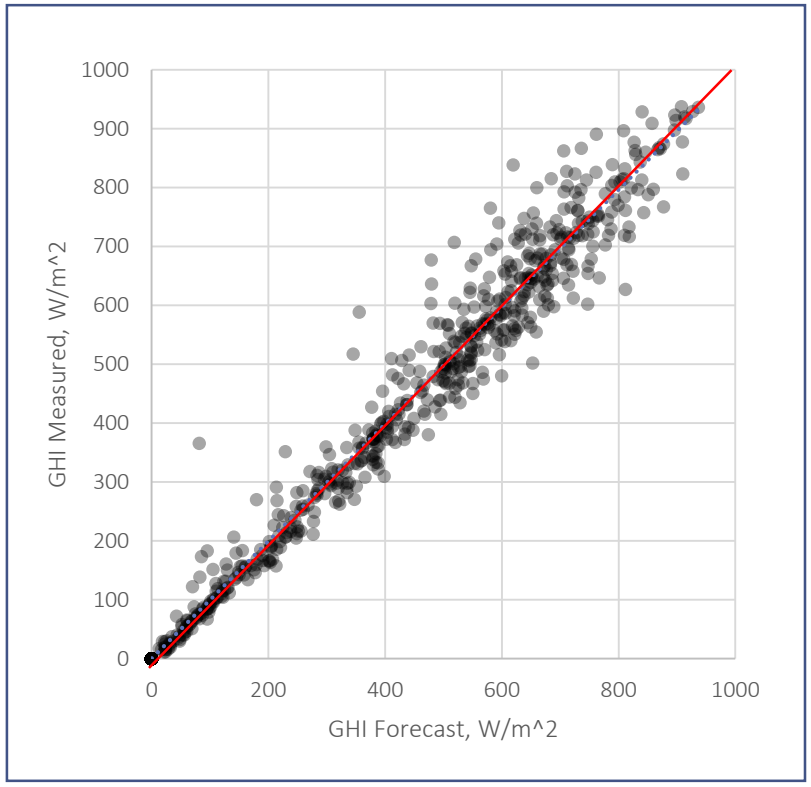
- Predicting ramp events is important for solar/storage scenarios
- With higher resolution forecast we can predict periods of variability



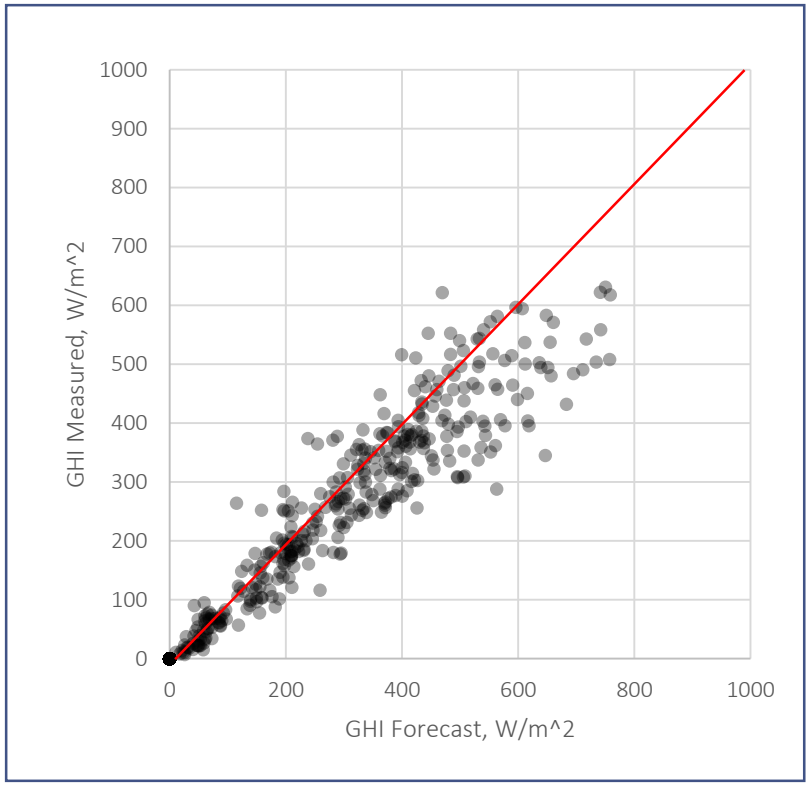
Forecast bias for different weather conditions

- We are capturing clear vs. cloudy conditions very well
- Current focus: improving predictions of the exact ramp characteristics

Clear conditions Kt > 0.7



Partly cloudy conditions 0.4 ≤ Kt ≤ 0.7



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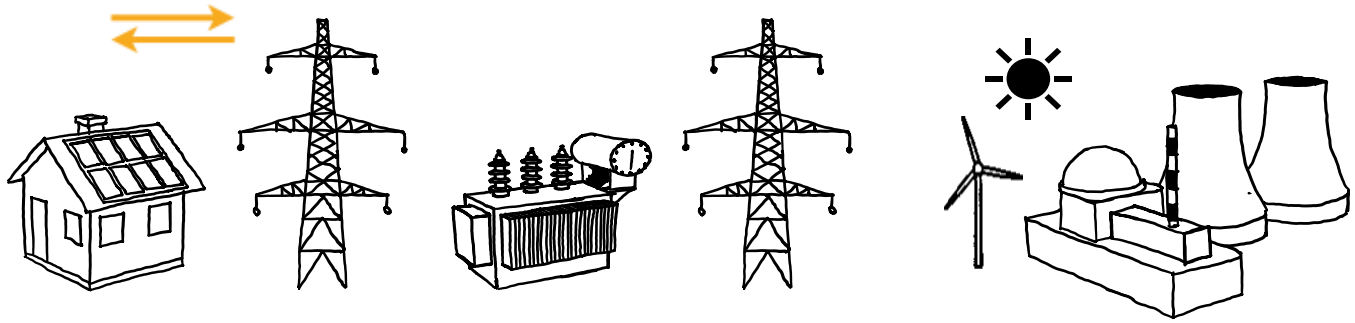

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Conclusions

- Cycling considerably impacts the lifetime of the battery
- There are applications on the distribution level and below for solar forecasting e.g. solar/storage
- Forecasting can provide grid support on the distribution level (firm load) and increased battery lifetime

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Thank you

Connect via:

✉ aswierc@cleanpower.com

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Appendix

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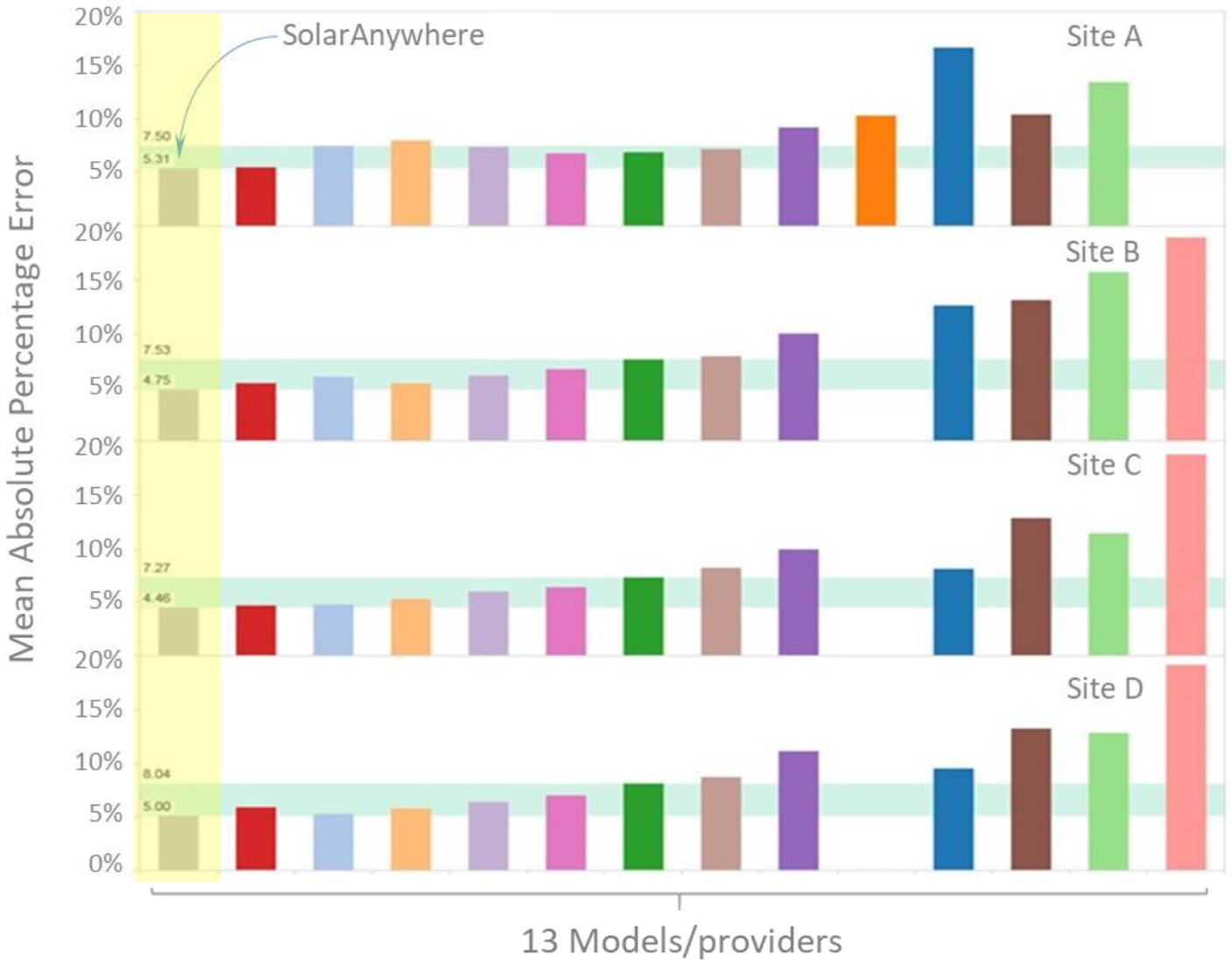
FleetView Rated Best Accuracy

Courtesy of Dr. Aidan Touhy, EPRI



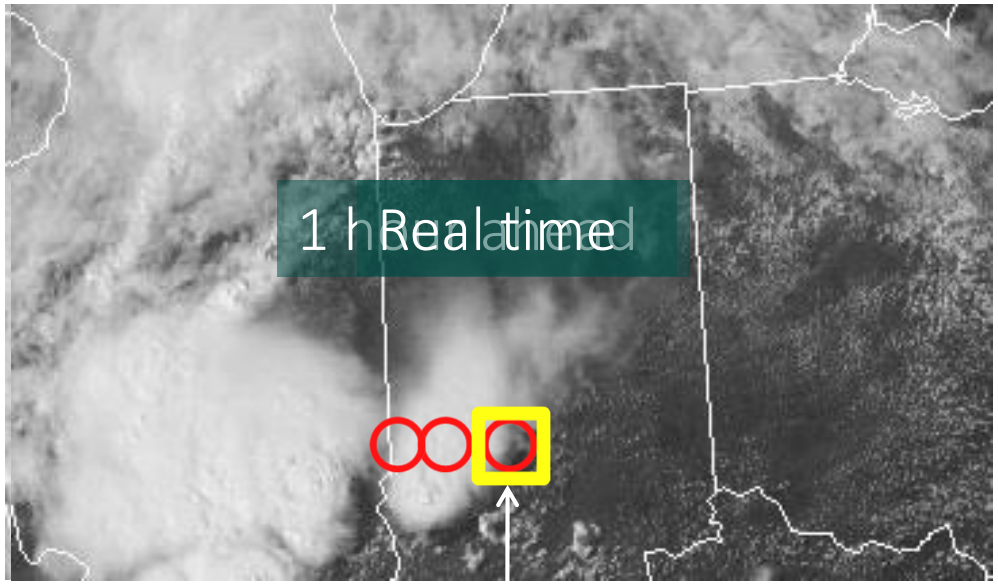
Hybrid, multi-model forecasting

Ramp and Near-Term

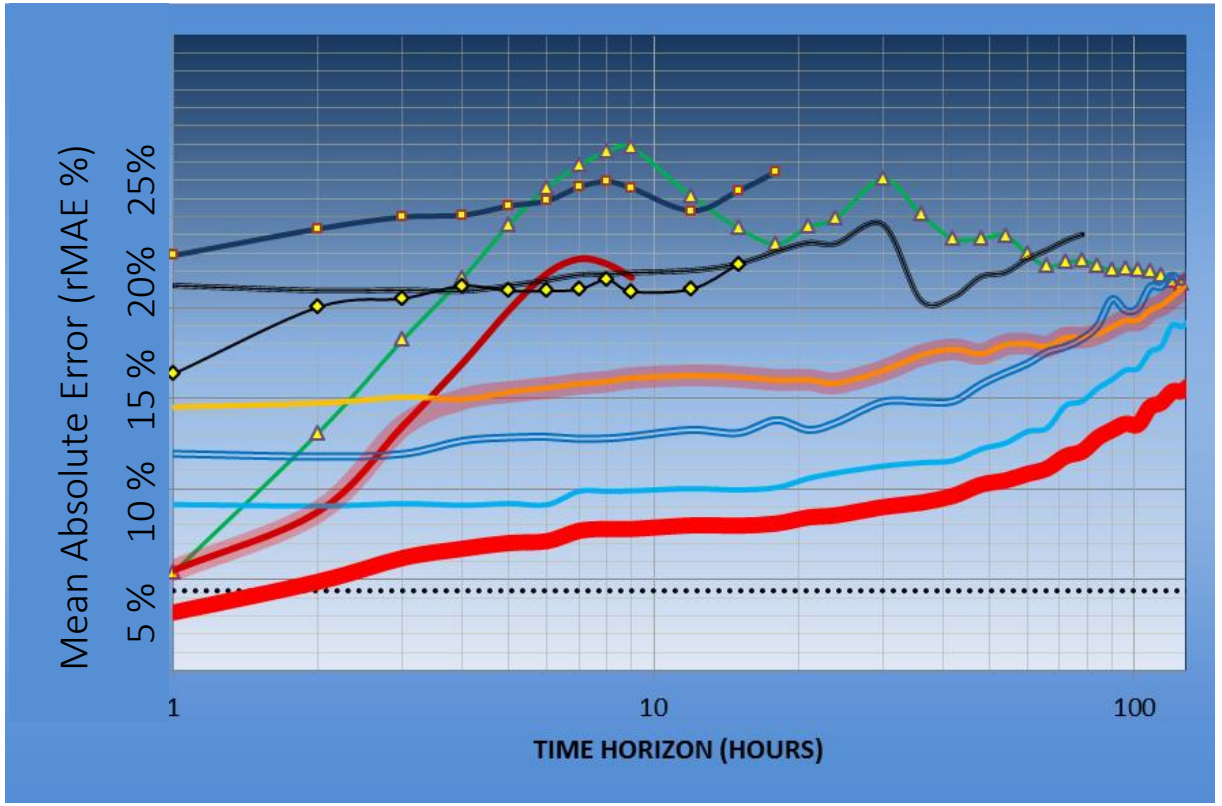
- Satellite-derived cloud motion vector (CMV)
- Sub-hourly forecasts in the near-term

Medium-Term

- Blended Numerical Weather Prediction Models (NWP)
- Day-ahead forecasts up to seven days ahead



Accuracy Leverages Multiple Models



Persistence

Satellite & NWP

Satellite CMV

NAM

GFS

RAP

ECMWF

HRRR

NDFD

Blended

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