Integrated Management of Solar Photovoltaic Generation

IEEE Oakland/East Bay LMAG

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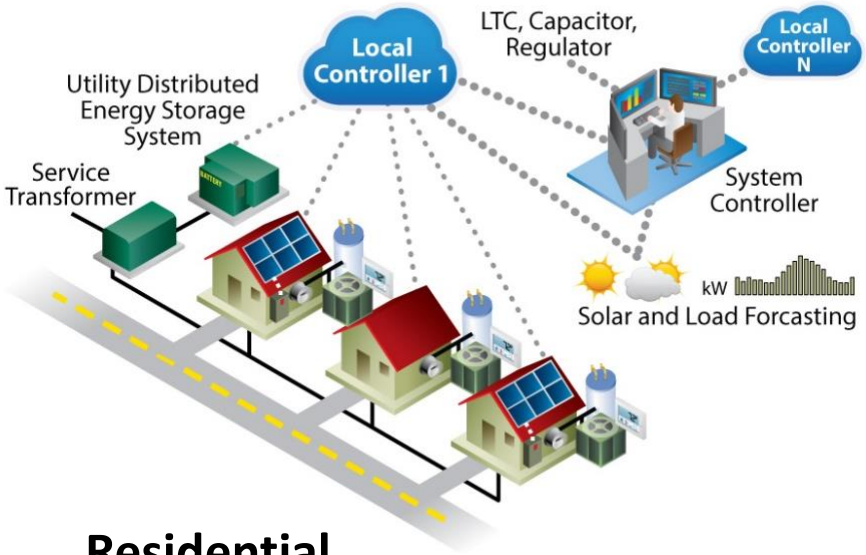
Welcome!

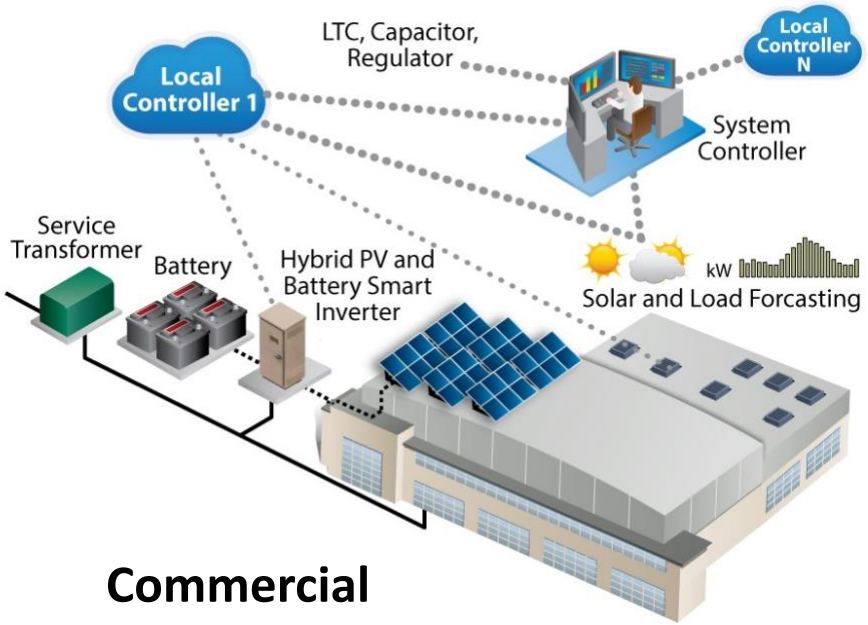
- Tanguy Hubert
  - Senior Engineer at EPRI
  - Power Systems, Optimization, Public Policy
  - At EPRI: DER integration, CBA
- What is DER integration?
  - Local:
    - Device-level support functions
    - DER group management: grid-tied, microgrids
  - System:
    - Groups, groups of groups
    - DERMS
- Today's presentation:
  - EPRI SHINES Project (DOE-funded)
  - Q&A

Project Objective

Beneficial Integration of solar photovoltaic generation, energy storage, load management, and advanced forecasting technique, with electric power delivery network through optimal control strategies at a minimized cost.



Residential



Commercial

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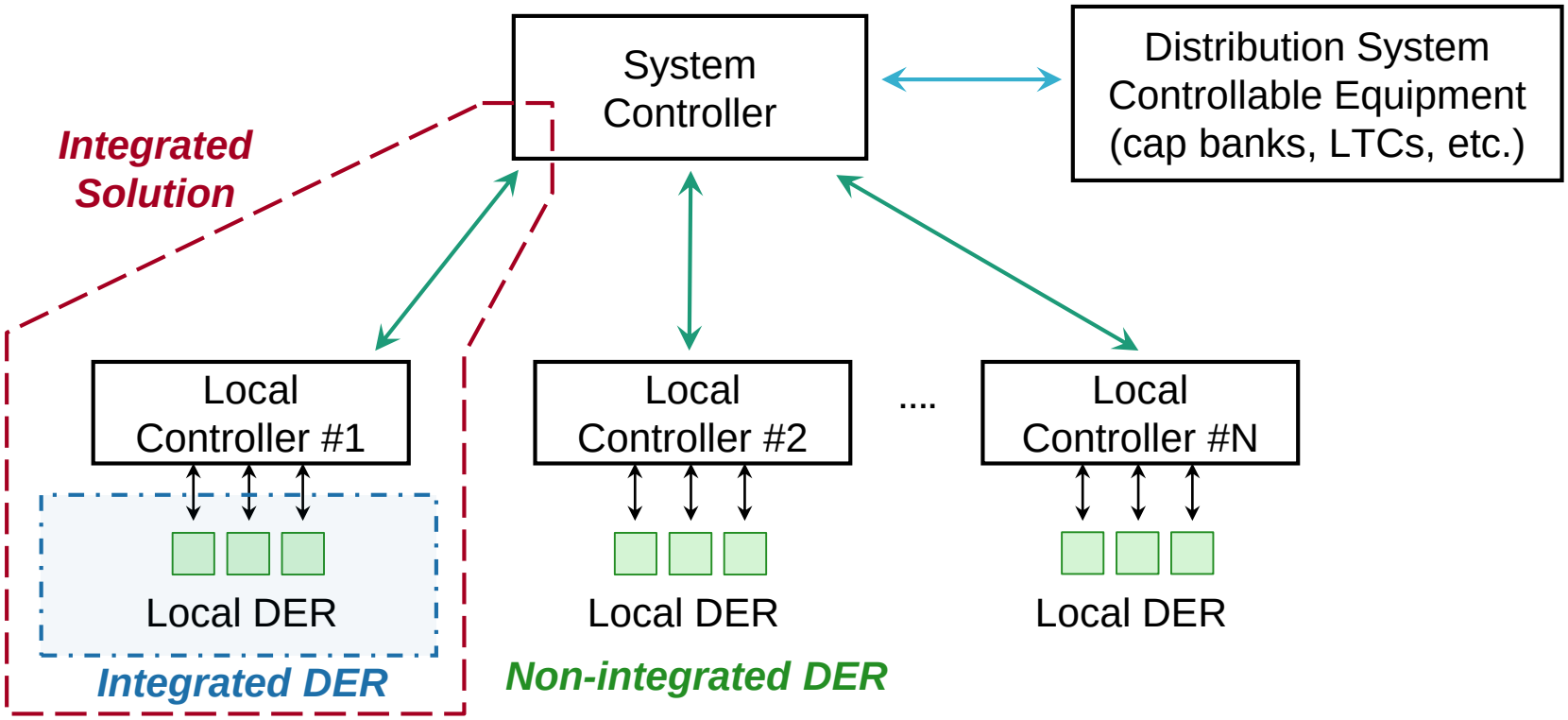
Conceptual Approach



- **Local controller** coordinates DER devices to satisfy local objectives while responding to operational requests received from system controller.
- **System controller** sends setpoints to local controllers and distribution system controllable equipment based on service and reliability needs identified.

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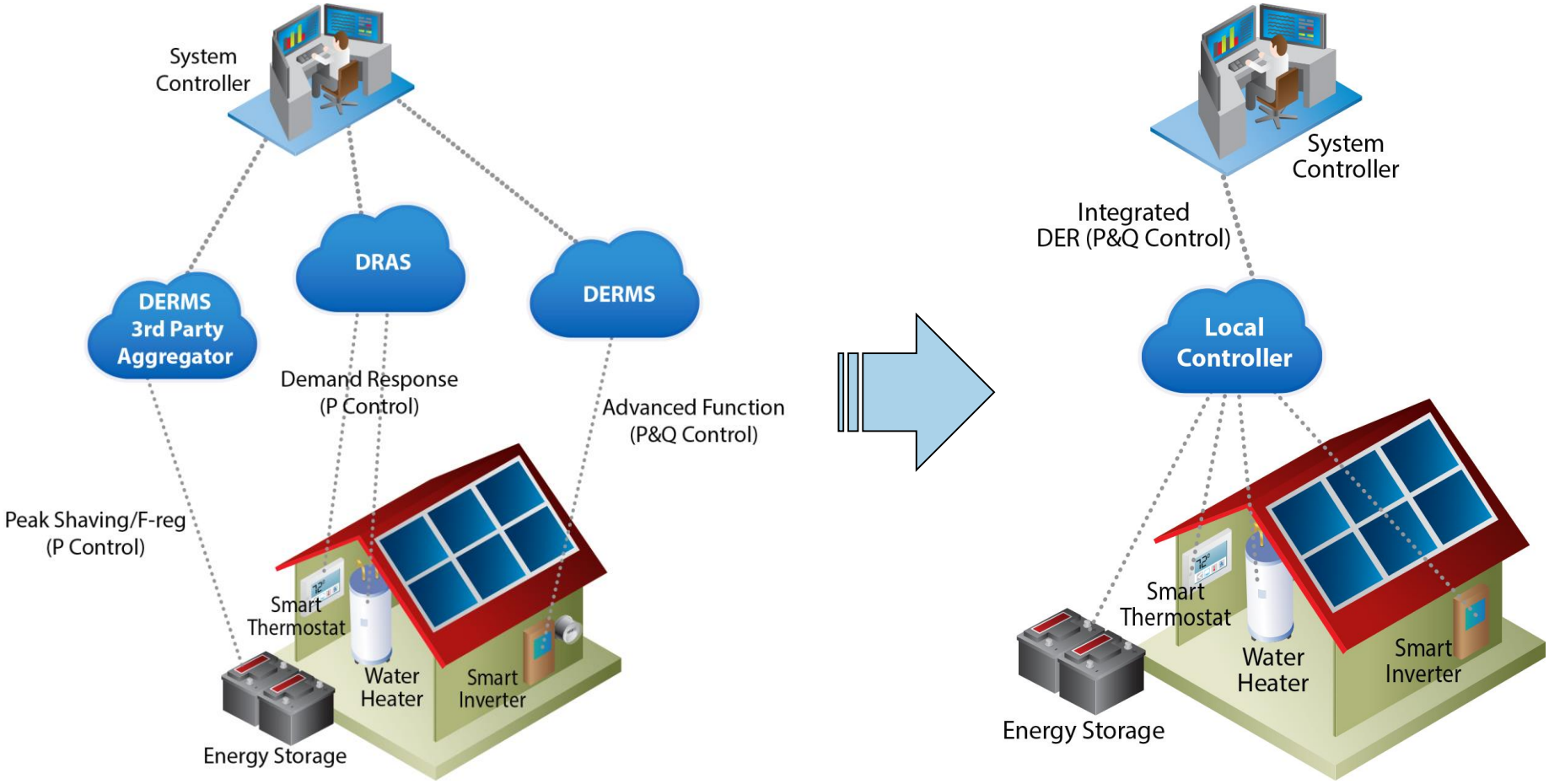
DER – Today vs Tomorrow



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Project Innovations

- Two-level control architecture with optimization algorithms at each level (system and local controllers)
- Controllable DER by combining energy storage and load management with solar PV
- Improved predictability of solar PV generation through high resolution solar forecasting
- Reduced lifetime cost of solar PV and storage system through reliable integrated smart inverters
- Optimum operation of resources and settings of controllers through distribution feeder modeling and impact studies
- Interoperable and scalable solution with open standards and communication protocols

EPRI SHINES Project Team

Utility Partners	University Partners	Industry Partners
• FirstEnergy*	• Case Western Reserve University (CWRU)	• Eaton
• NYPA*	• City University of NY (CUNY), Queens College	• Clean Power Research
• ConED*		• PowerHub
• Southern Co*		• LG Chem
• Gulf Power*		• Smart Inverter vendors
• LADWP†		
• AECC†		
• AEP†		
• Duke†		
• SMUD†		
• Gas Natural SDG†		

EPRI
• Integration of DER (P174)
• Energy Storage and DG (P94)
• End-Use EE and DR (P170)
• Information and Com Tech (P161)
• System Studies
• Economic Analysis

** DOE proposal team member*

† Supplemental Project Participants

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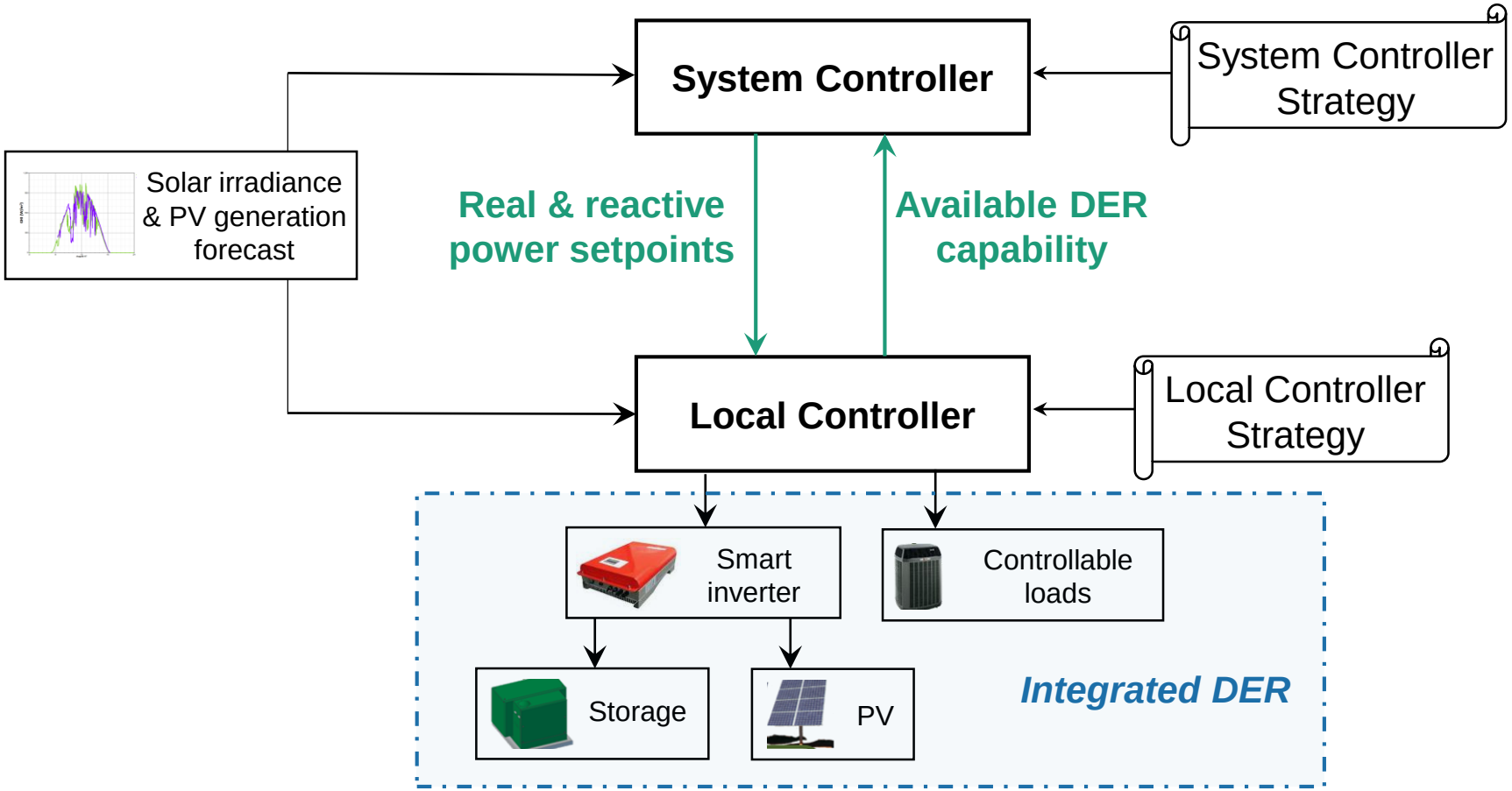
Two-Level Control Architecture – Design, Development, & Demonstration



- **Local controller** sends available DER capability information to system controller.
- **System controller** sends real and reactive power setpoints to local controller.

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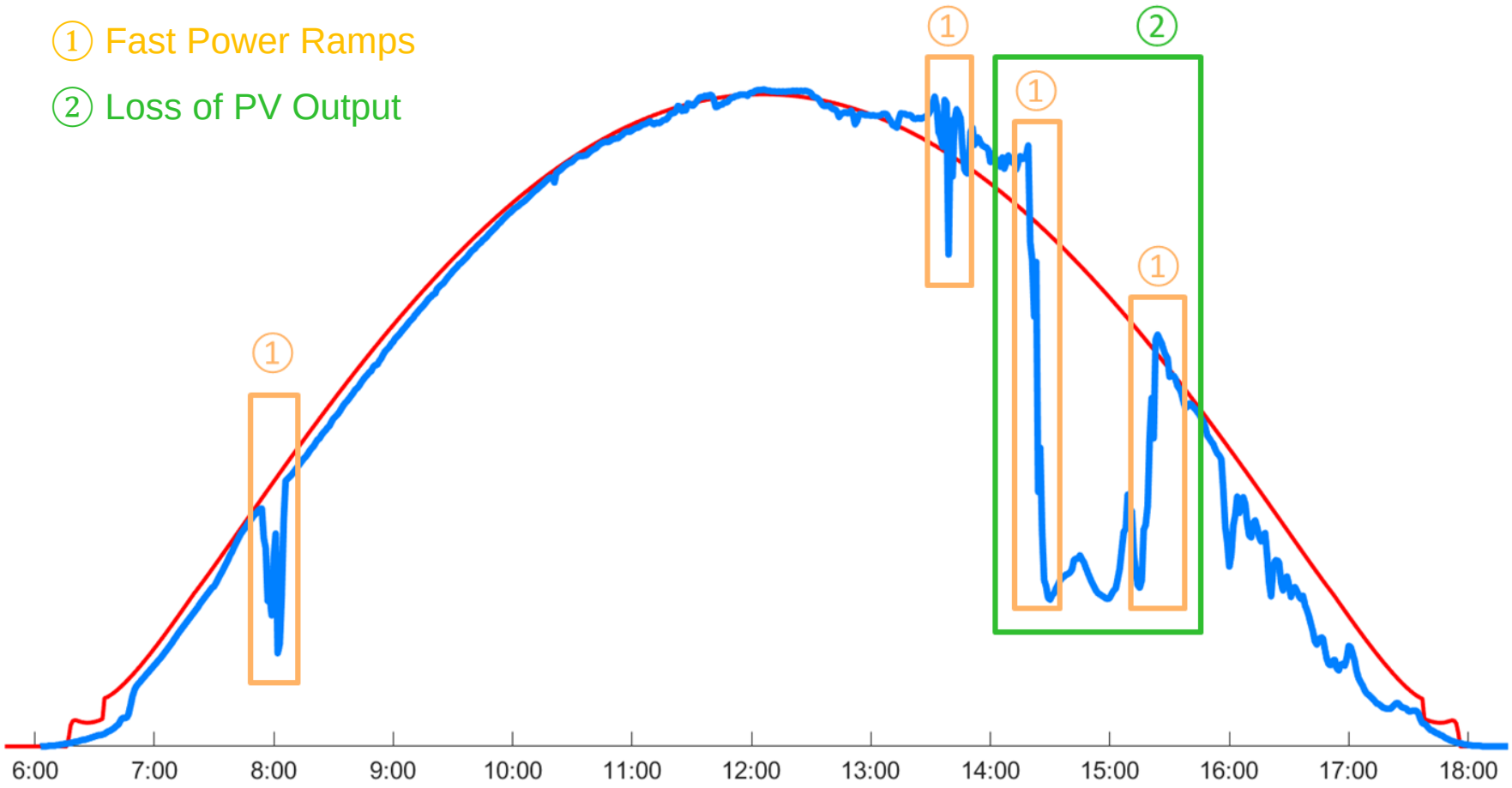
Local Controller Requirements



Illustrative Solar Irradiance Profile (blue) and Clear-Sky Profile (red).

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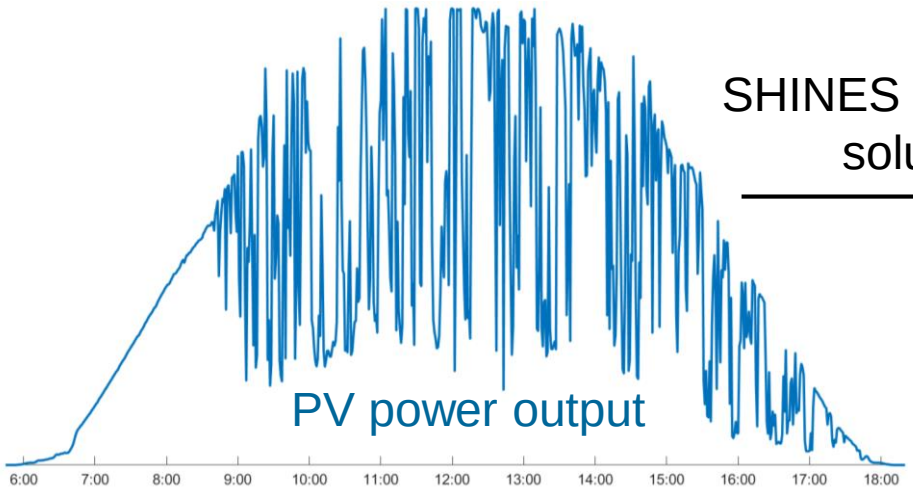
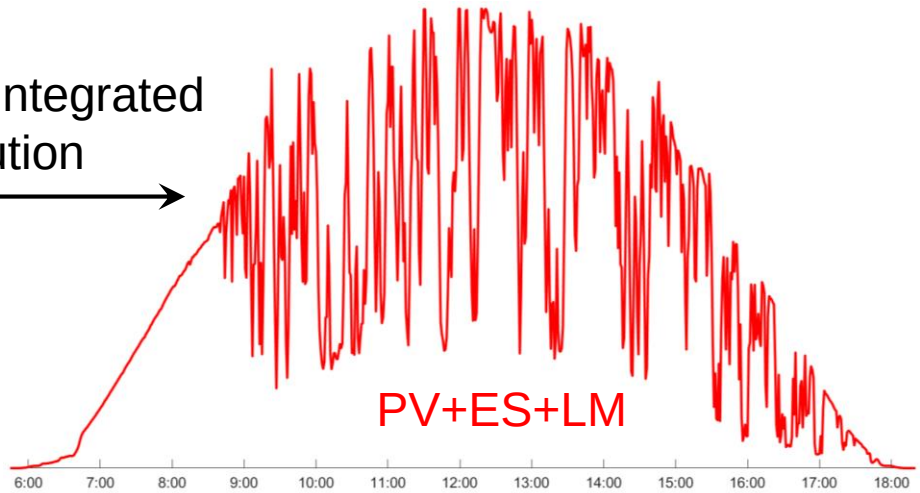
Local Controller Requirement: Enable PV Ramp Control Using Storage and Load Management

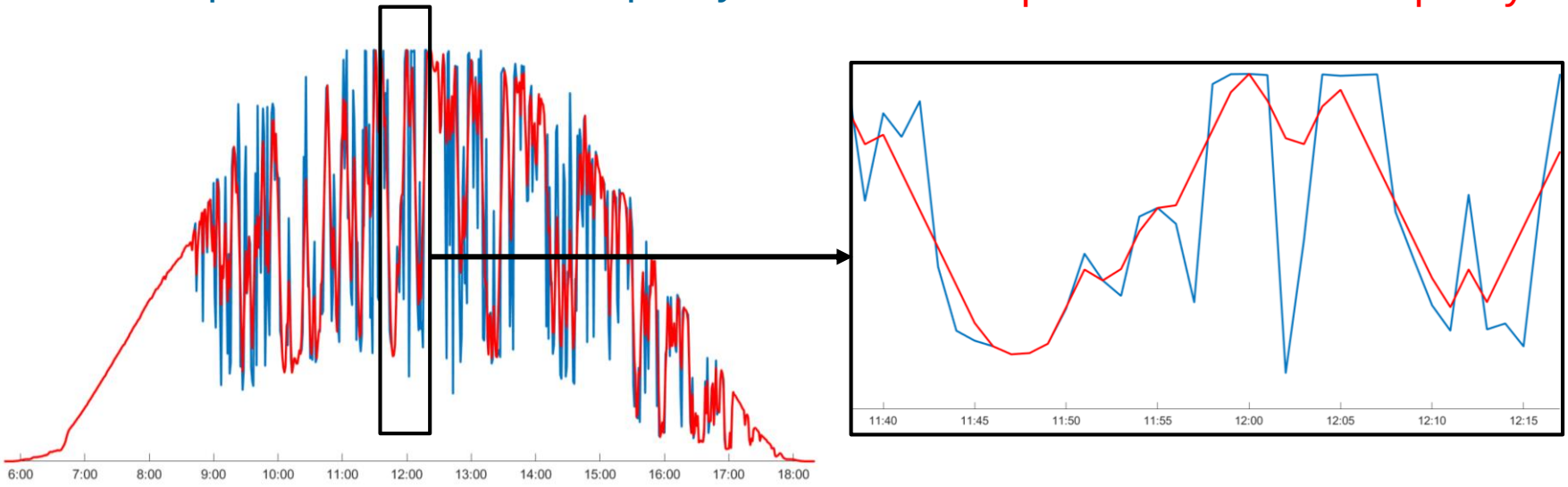


SHINES integrated solution →



Max ramp rate: +78% of PV capacity/min

Max ramp rate: 10% of PV capacity/min



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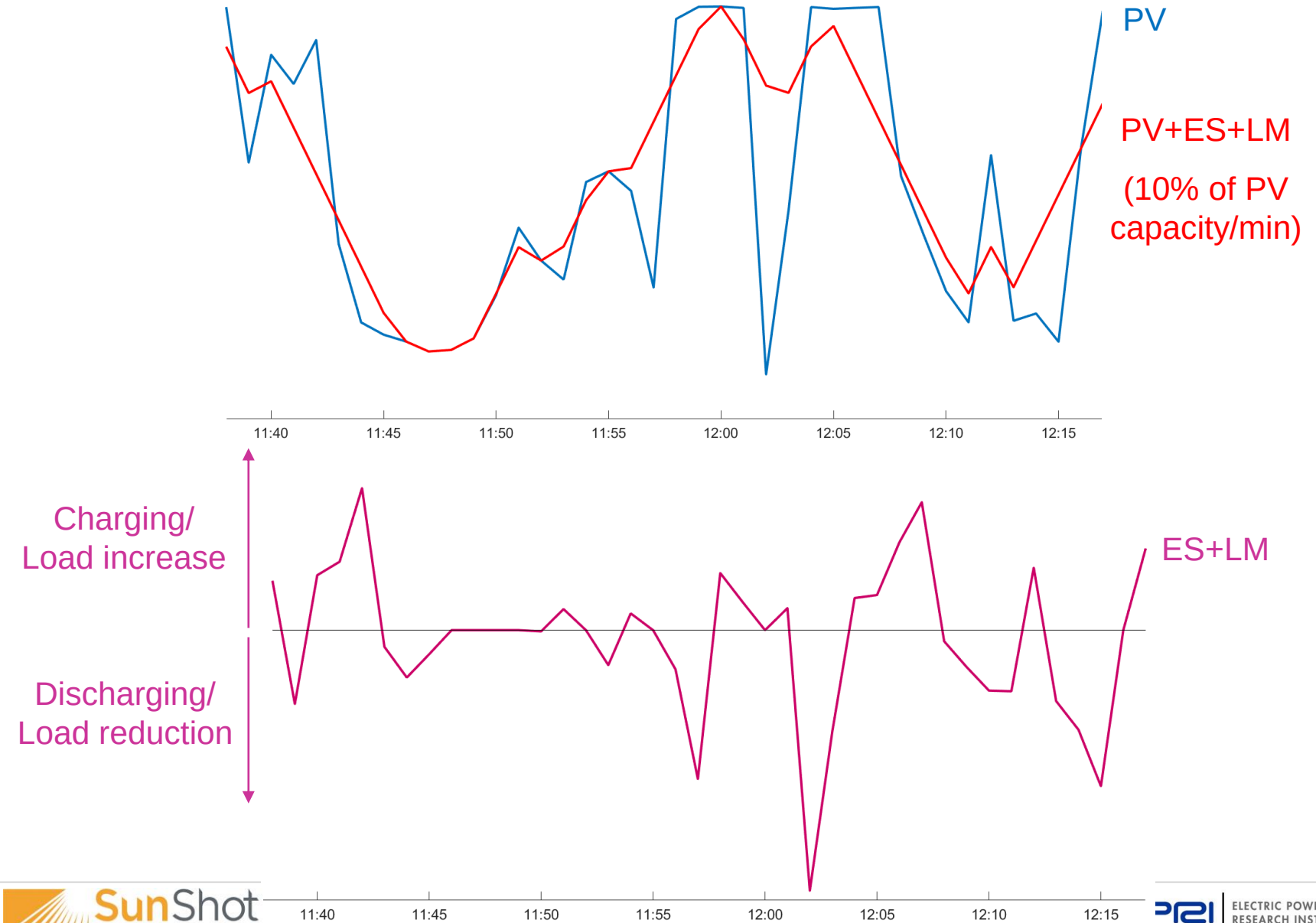
Local Controller Requirement: Enable PV Ramp Control Using Storage and Load Management



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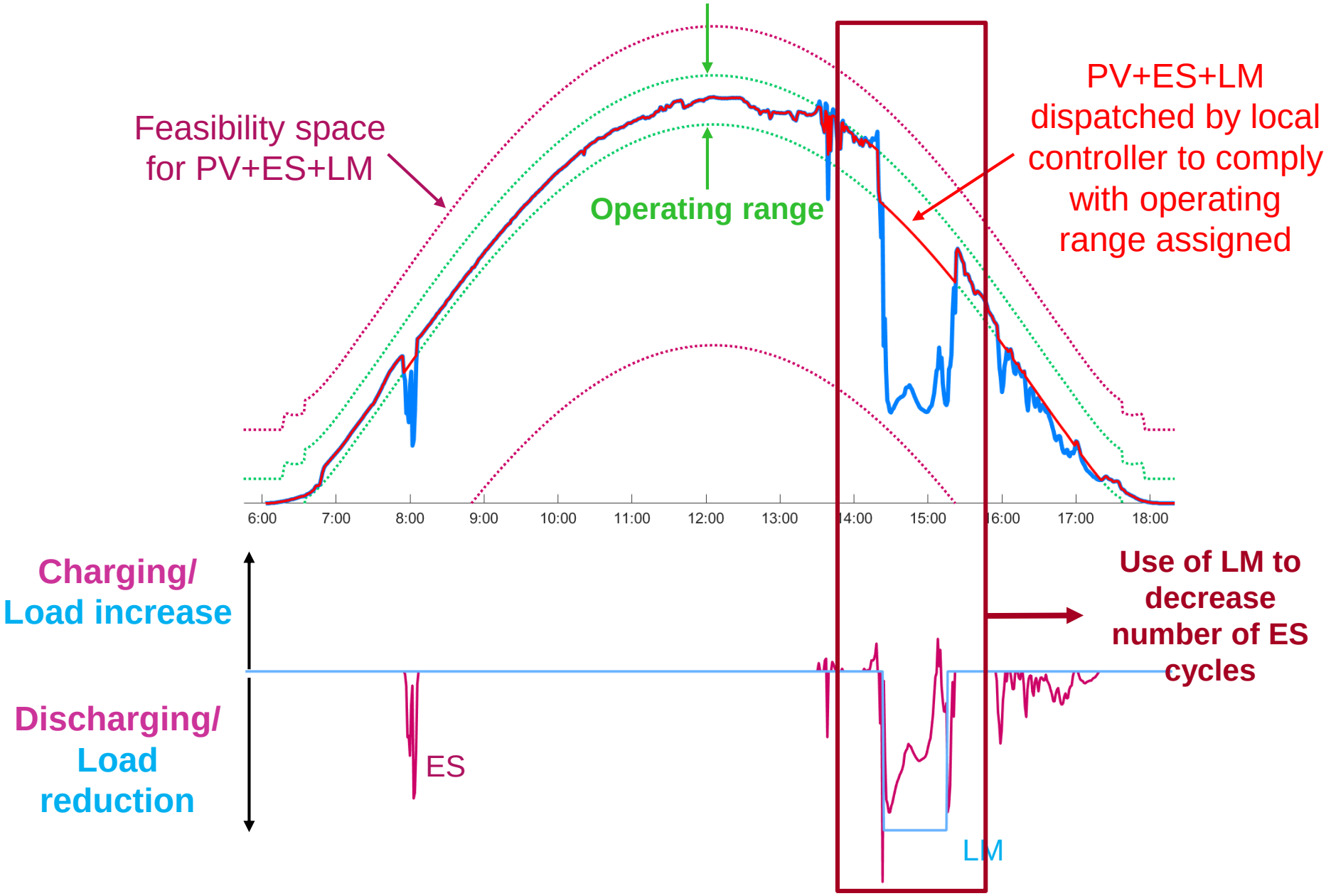
Interaction between System and Local Controllers



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Site #1: Two Residential Homes

Pensacola, FL

	Residential site
Owner	Individual home owners
Utility	Southern Co/Gulf Power
PV	Two; each 5kW
Energy Storage	14.4kW/40kWh
Solar Forecasting	CPR
Smart Inverter	PV Smart Inverter - SMA, PowerHub SiC-based 4-quadrant DESS
Battery	Saft
Local Controller	Intwine Connect
System Controller	TBD
Data Monitoring and Analysis	Home Owners, EPRI

Site #1: Two Residential Homes

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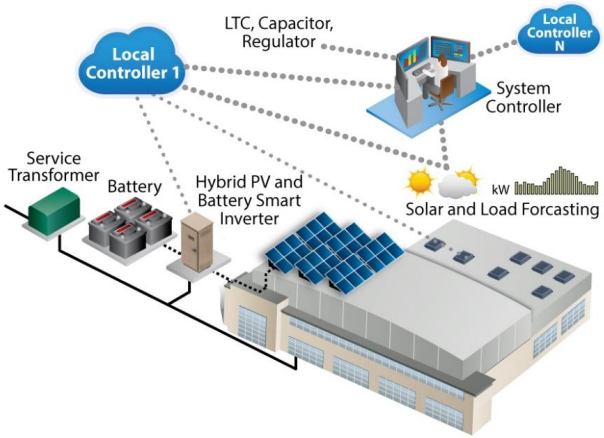
Local Controller has two distinct roles, at two different timescales

1) Local Controller acts as Energy Scheduler
   - Optimally schedules all DER assets over forward-looking time horizons based on demand forecast, PV output forecast, interconnection constraints, electricity prices, and local control objective.
   - Sends out commands to all DER assets.
2) Local Controller acts as ES EMS
   - ES is “closing the gap” in real time between anticipated and realized values (demand, PV output, etc.)
   - Fast control loop making adjustments to the ES output is located at the local controller level.

Site #2: Commercial Demonstration



Case Western Reserve University (CWRU)
Cleveland, OH

	Commercial Site
Owner	CWRU
Utility	FirstEnergy/MCCo
PV	50kW
Energy Storage	50kW/200kWh
Solar Forecasting	CPR
Smart Inverter	Eaton AC-coupled hybrid Inverter
Battery	LG Chem, SuperCap
Local Controller	Eaton
System Controller	Eaton
Data Monitoring and Analysis	CWRU, EPRI

Site #3: Commercial Demonstration

City University of New York (CUNY), Queens College

Flushing, NY

	Commercial Site
Owner	Queens College/CUNY
Utility	NYPA/ConED
PV	50 - 60kW
Energy Storage	100kW/200kWh
Solar Forecasting	CPR
Smart Inverter	Dynapower Power DC coupled hybrid inverter
Battery	LG Chem
Local Controller	Intwine Connect
System Controller	TBD
Data Monitoring and Analysis	Queens College, EPRI

Together…Shaping the Future of Electricity

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