



# DER-CAM

DECISION SUPPORT TOOL FOR  
DECENTRALIZED ENERGY SYSTEMS

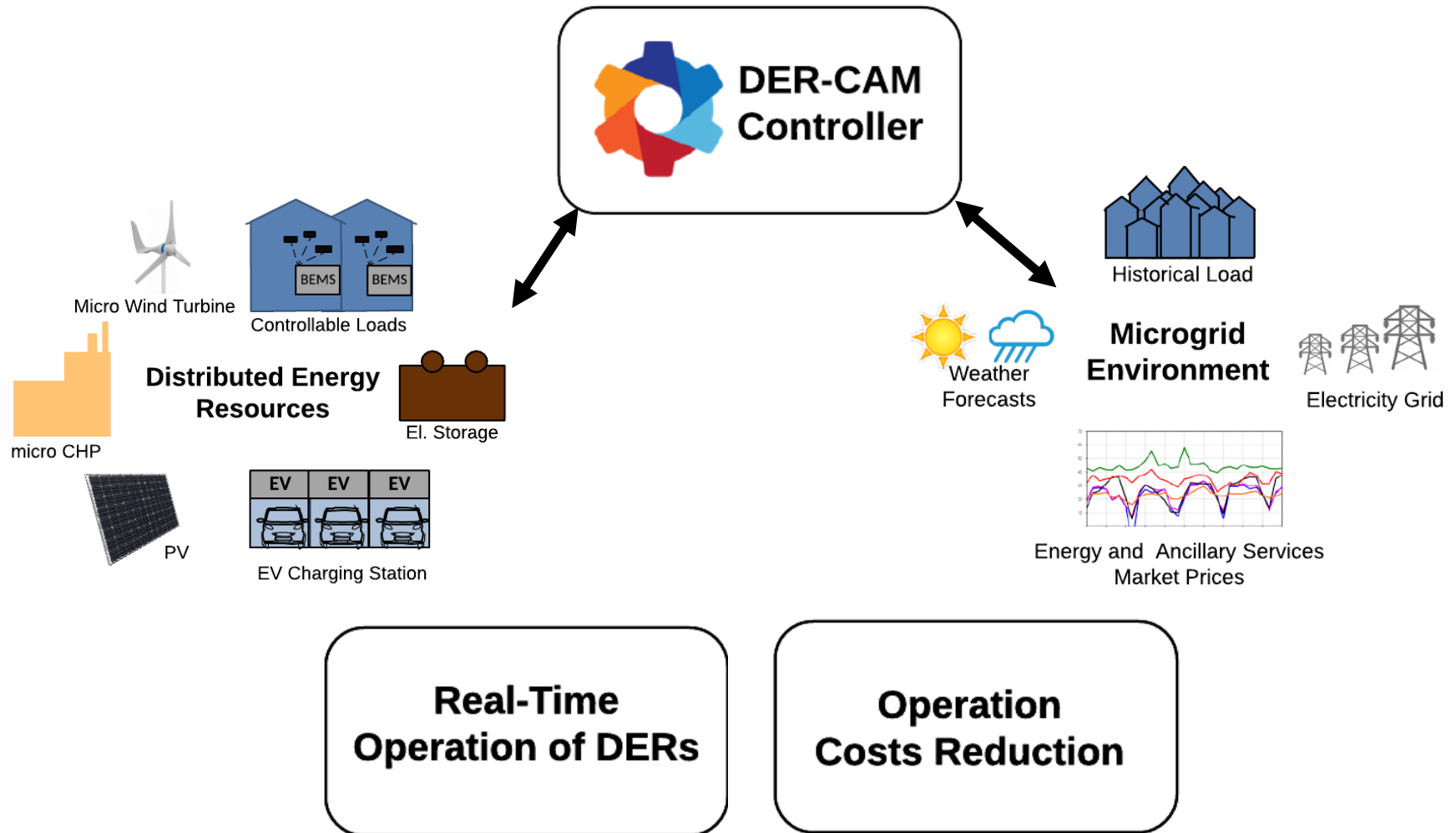
ANALYTICS | PLANNING | OPERATIONS

## DER-CAM Microgrid Controller

IEEE Northwest Energy Systems Symposium  
Seattle, WA  
April 4-5, 2018



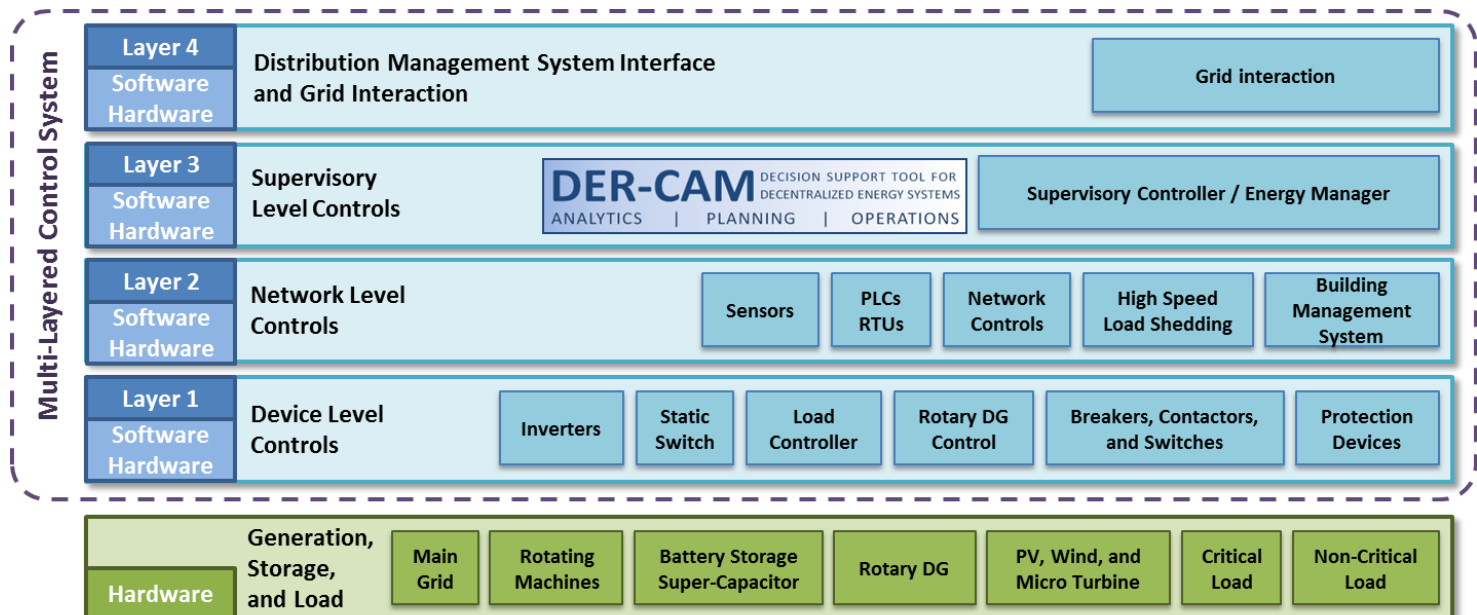
# DER-CAM Microgrid Controller



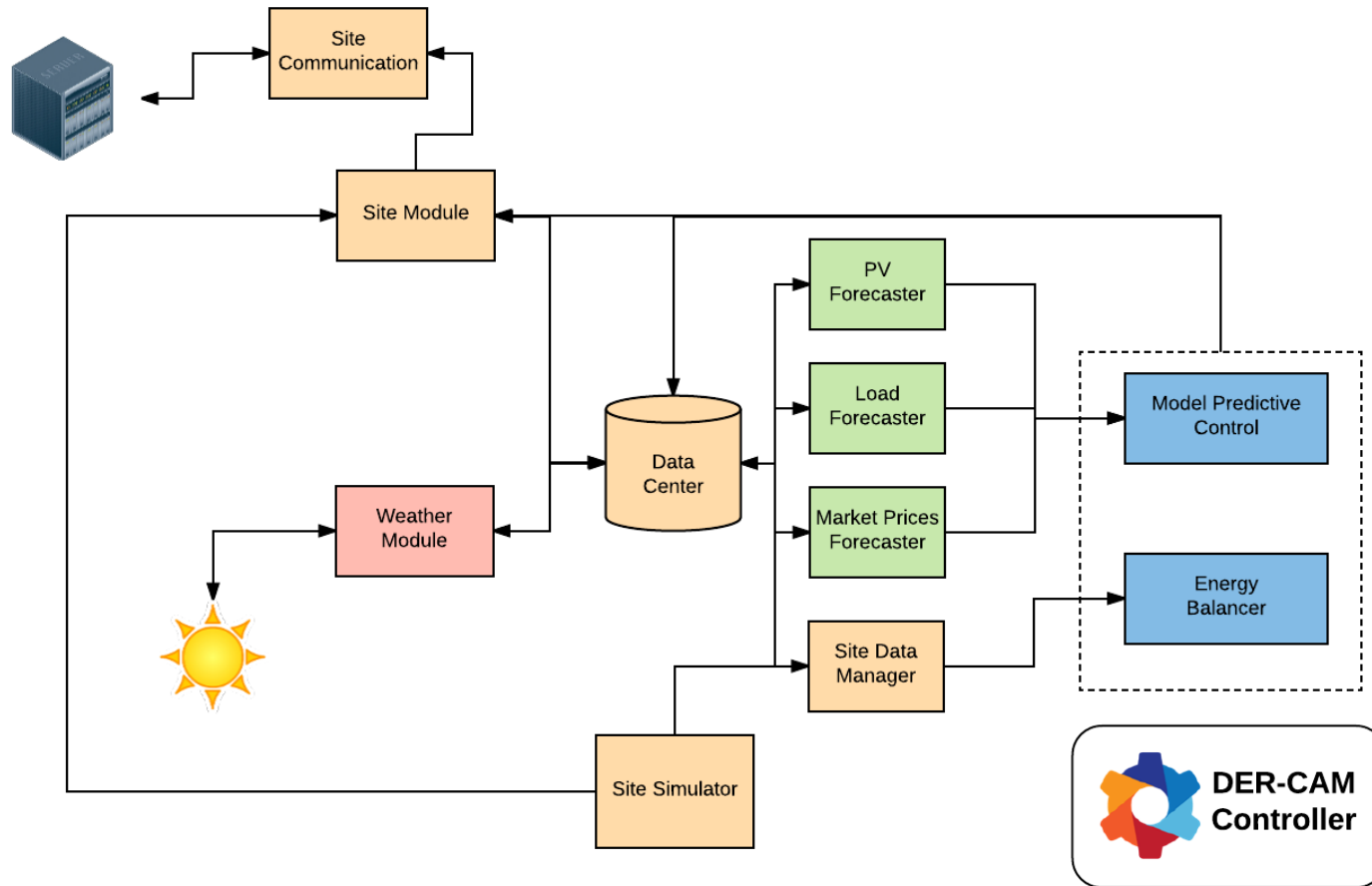
# A Supervisory Controller

## Supervisory Controller

- Determines in advance the optimal setpoint strategy to be implemented by the network control layer.
- Performs an economic optimization considering technical and user constraints
- Acts as an interface between SCADA systems and utility grid/markets platforms.



# Architecture



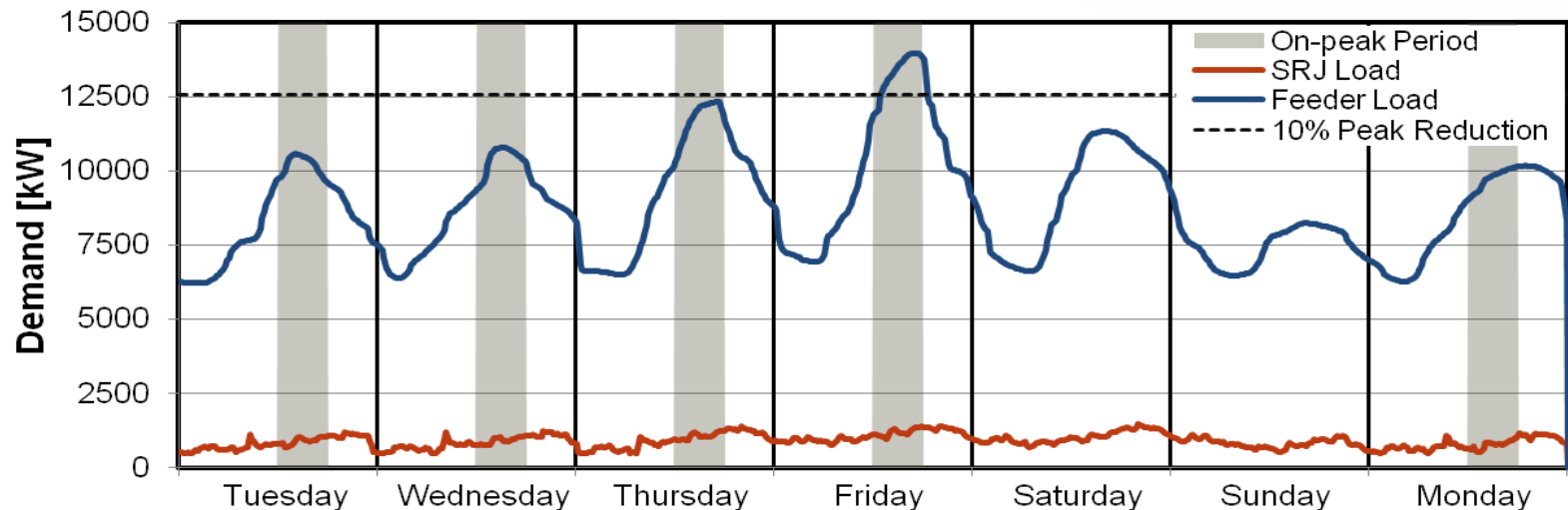
# SRJ Microgrid Application

## Santa Rita Jail – Operations DER-CAM Test Case

### Overview

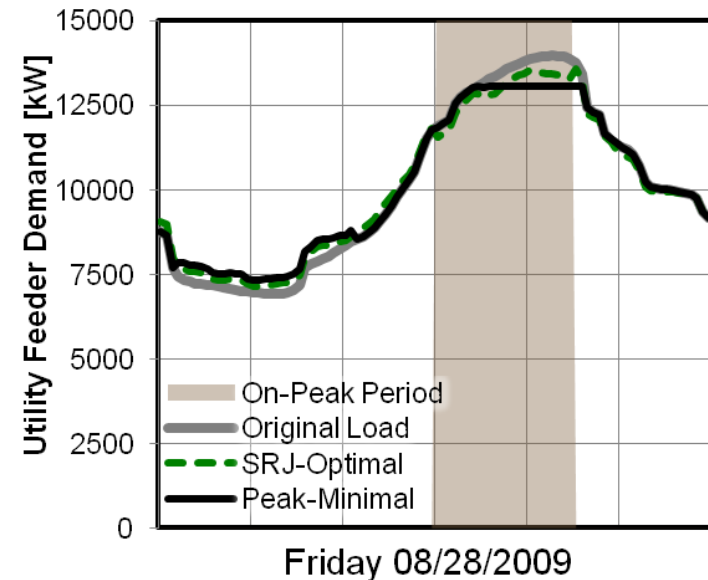
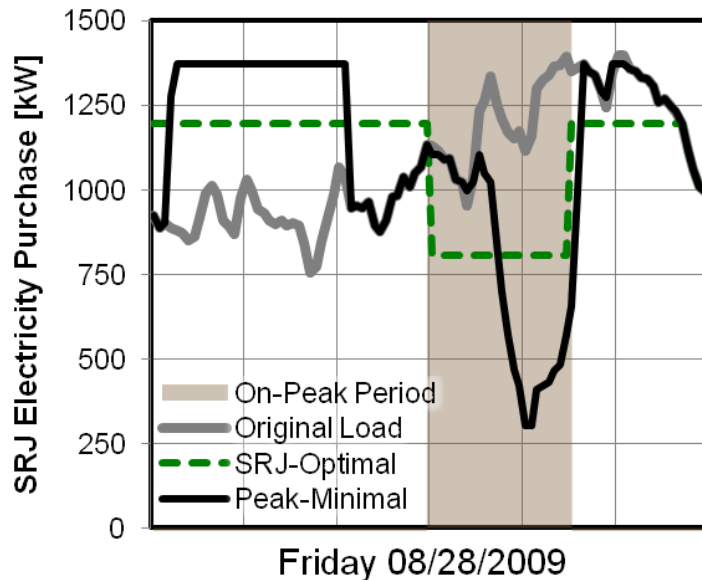
- 4,500 inmate facility; 3MW Peak load
- existing DER: 1.2 MW PV + 4 MWh / 2MW battery

Objective: evaluate potential contribution for feeder peak reduction



# SRJ Microgrid Application

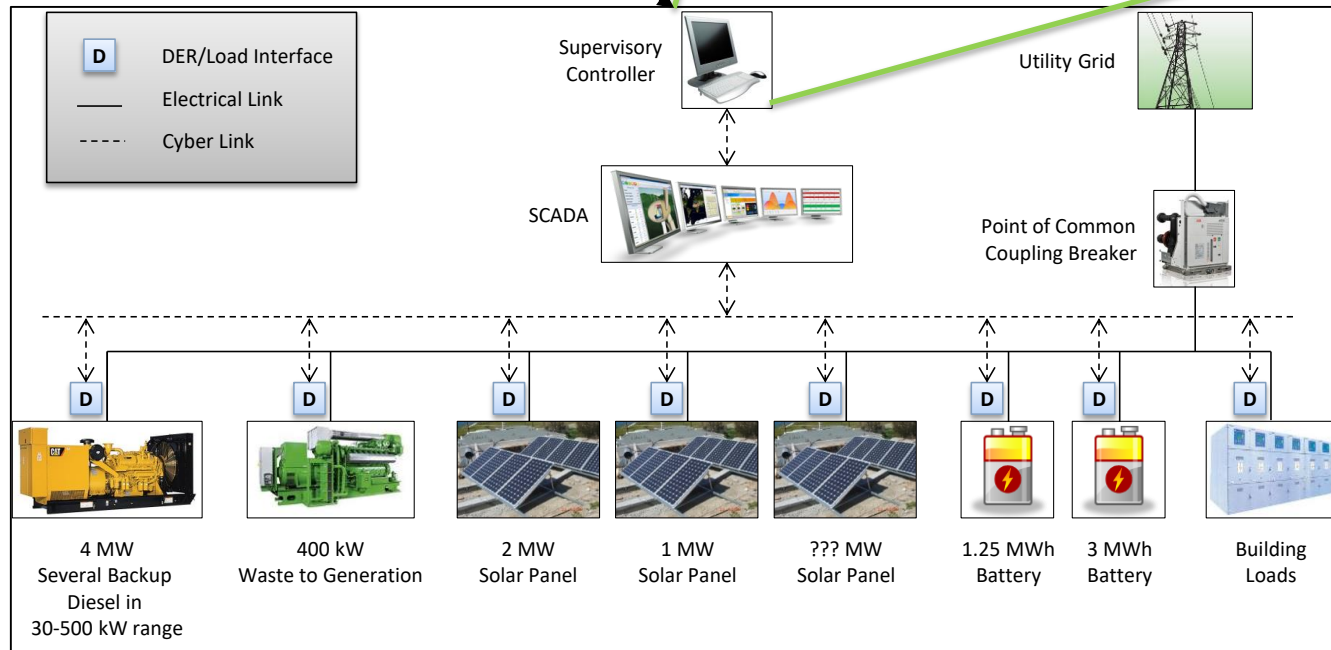
## Santa Rita Jail – Operations DER-CAM Test Case



	SRJ-optimal	Peak-minimal
Energy Cost	\$54,662	\$54,721
Power Cost	\$20,928	\$25,990
Peak Reduction	2.7%	6.5%

# FHL Microgrid Application

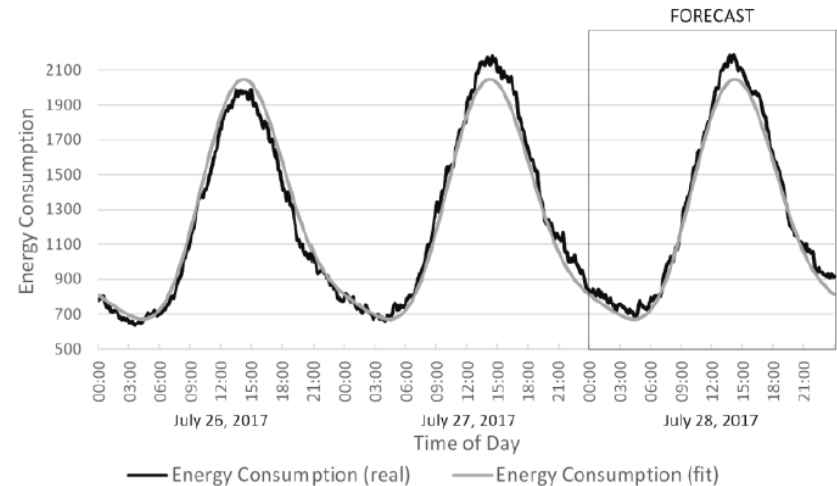
Fort Hunter Liggett  
(DOE Facility)



# FHL Load Forecast

## Day ahead Load Forecast (every 15 min)

- Based on the past 4 days of the same type (week, weekend/holiday).
- A Fast Fourier transform is applied to remove the high frequency noise of the historical load profile.



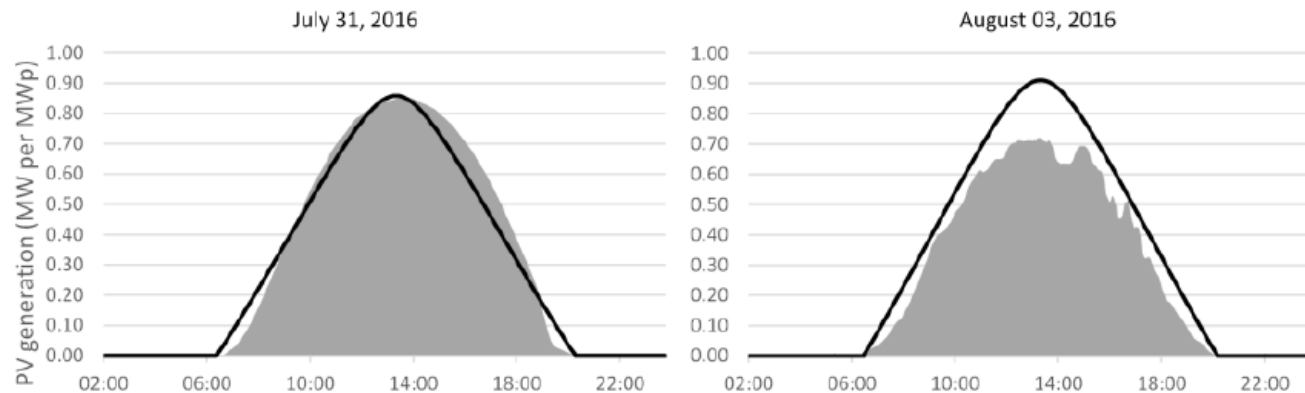
<i>Day</i>	<i>Root Mean Square Error</i>	<i>Median Absolute Dev.</i>	<i>Median Relative Dev.</i>
Jul 28, 2016	63.33	51.95	3.96 %
Jul 29, 2016	44.35	31.61	3.27 %
Jul 30, 2016	154.64	56.74	9.18 %
Jul 31, 2016	69.32	49.10	5.32 %
Aug 1, 2016	143.01	104.97	10.03 %
Aug 2, 2016	51.54	29.98	3.36 %
Aug 3, 2016	117.15	78.64	6.99 %
Week	103.45	48.42	6.18 %



# FHL PV Forecast

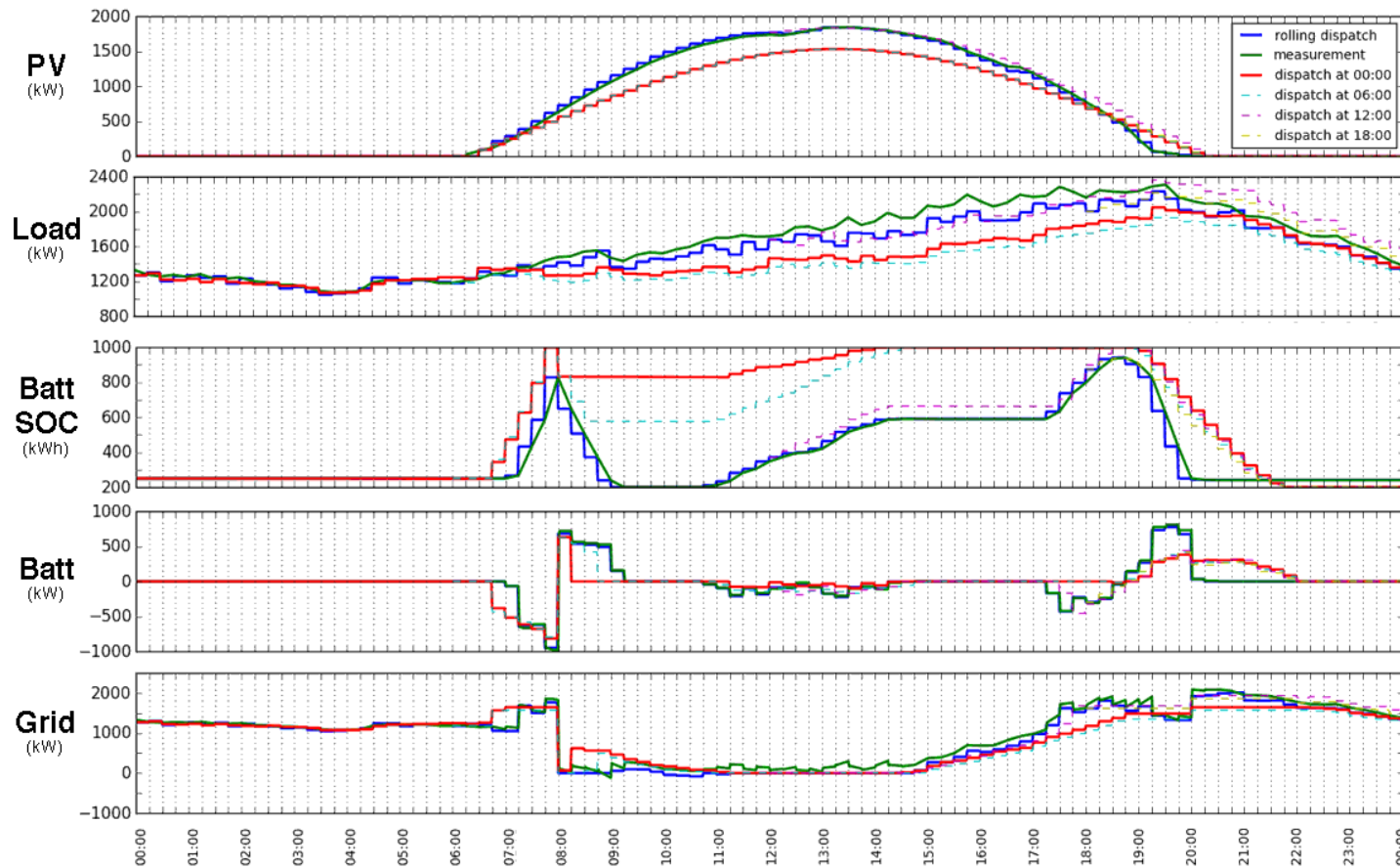
## Day ahead PV Forecast (every 15 min)

- Based on the clear sky characteristic of the photovoltaic generation.
- The clear sky is corrected by a coefficient associated with the weather forecast for each hour.



Day	Root Mean Square Error	Median Absolute Dev.	Median Relative Dev.
Jul 28, 2016	105.66	91.68	16.22 %
Jul 29, 2016	73.85	54.33	10.20 %
Jul 30, 2016	64.37	37.07	8.31 %
Jul 31, 2016	70.90	59.95	8.93 %
Aug 1, 2016	68.37	38.34	5.44 %
Aug 2, 2016	79.27	47.65	6.60 %
Aug 3, 2016	137.83	131.92	27.73 %
Week	88.02	64.70	11.60 %

# FHL One Day Operation



# FHL Economic Analysis

## Day ahead PV Forecast (every 15 min)

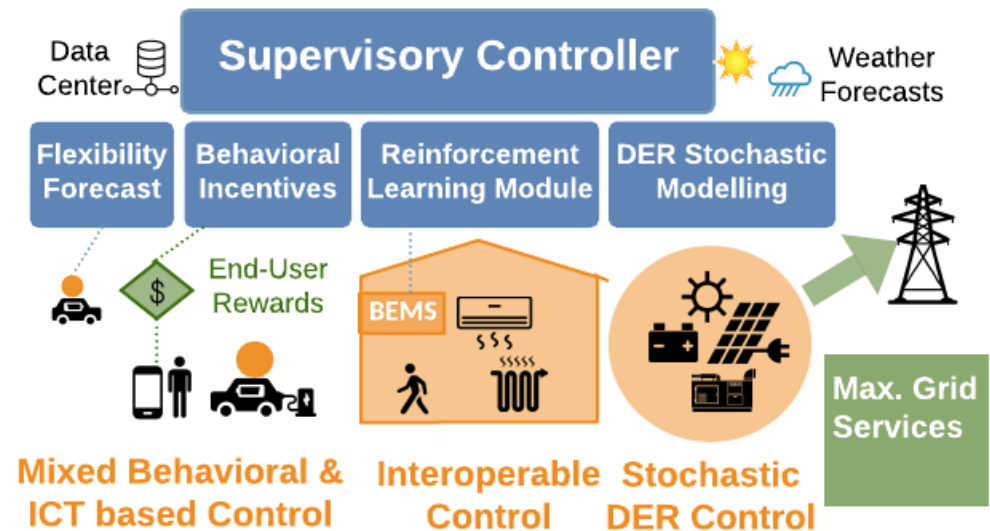
- 30% reduction of total operation cost
- Main reduction is associated with peak demand charges
- Still a significant potential for improving forecasts and control approach.

Tariff			
peak	off-peak	coincident peak	non-coincident peak
\$/kWh		\$/kW	
0.1395	0.0745	19.34	14.44

Total Costs					
Scenario	coincident peak costs	non-coincident peak cost	energy costs	total costs	PV curtailed costs
Basic Rule	256779	197762	-277640	<b>176901</b>	410.5
Controller	187399	193271	-255344	<b>125326</b>	313.6
Controller + Perfect forecasts	133683	169707	-253982	<b>49408</b>	281.2

# Upcoming Features

- Expanding the portfolio of controlled DERs
- Stochastic-based Model Predictive Control
- State/Fuzzy controller for 1 min base energy balance
- Planned islanding functionalities
- Interoperability with existing controllers (e.g. building management systems)
- Control based on interactions with end-users
- Wholesale energy and ancillary services market participation



# *THE END*

## Contact Information

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