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CPS ENERGY EXPERIENCES WITH HIGH PENETRATION PV

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OVERVIEW



- Fast Facts about CPS Energy
- PV Deployments and Experiences
- Grid of Future Test Bed

WHO WE ARE



- Municipally owned
- Vertically integrated
- 7 % of ERCOT
- Service territory spans 1514 square miles and 30 franchise cities
- Customers
 - 728,000 electric
 - 328,000 natural gas
- 4.9 GW Peak
- 7.8 GW Generating Capacity
 - 1.2 GW Renewables, mostly wind
 - 129 MW Solar PV on-line
 - 315.3 MW PV expansion next 3 years

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SOLAR PV LOCATIONS



Operating PV Totals

- Distributed 18 MW
- Utility-Scale 130 MW

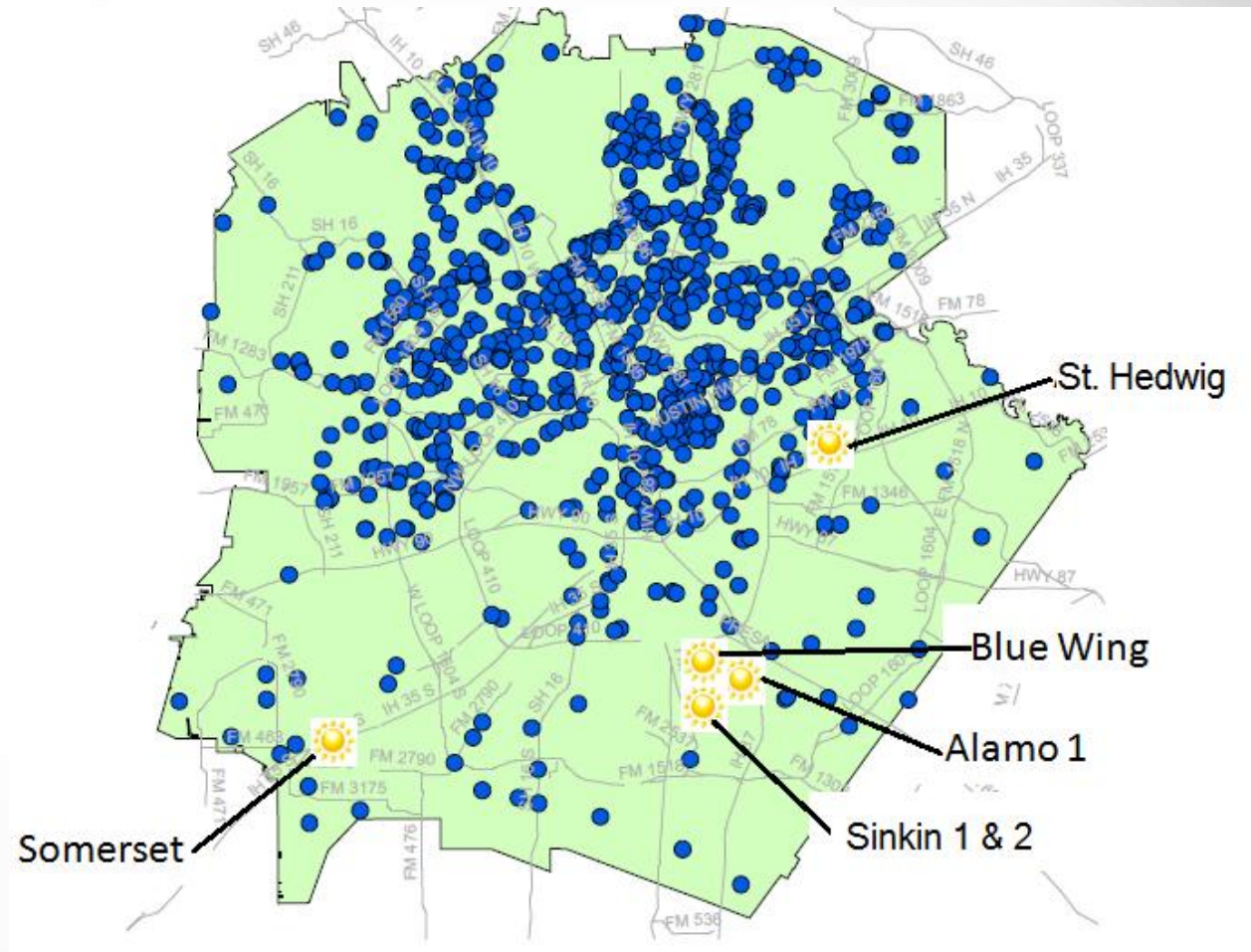
Utility-Scale in Operation

Transmission-Connected

- Alamo 1 40.7 MW
- Eclipse 39.6 MW
(outside of map)

Distribution-Connected

- Sinkin 19.8 MW
- Blue Wing 13.9 MW
- Somerset 10.6 MW
- St. Hedwig 4.4 MW



PLANTS



**Blue Wing
13.9 MW Fixed Tilt**



**Sinkin Centennial
19.8 MW 1-axis Tracking**



**Alamo 1 40.7 MW
1 & 2-axis tracking**

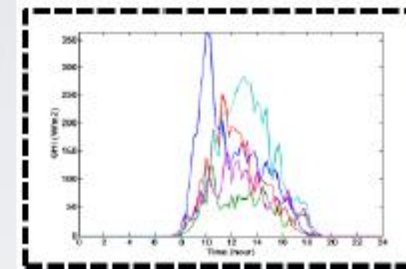
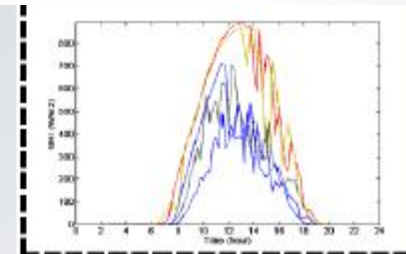
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INTERMITTENCY CHARACTERIZATION

Three characteristics evaluated for each day

- Day Bias (am, pm, or evenly balanced)
- Variability Index (VI)
- Clearness Index (CI)

Bias	No.	Conditions	Description
AM	1	VI < 2 CI >= 0.5	Ideal day
	2	VI < 2 CI < 0.5	Overcast day
EVEN	3	VI <= 2 VI > 6	Mildly variable day
	4	VI >= 6 VI < 10	Moderately variable day
PM	5	VI >= 10	Highly variable day



VI / CI Type					
	1	2	3	4	5
Even	11	4	25	25	3
AM	2	5	15	22	2
PM	49	14	56	47	5

GRID OF FUTURE TEST BED



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CHANGE DRIVERS



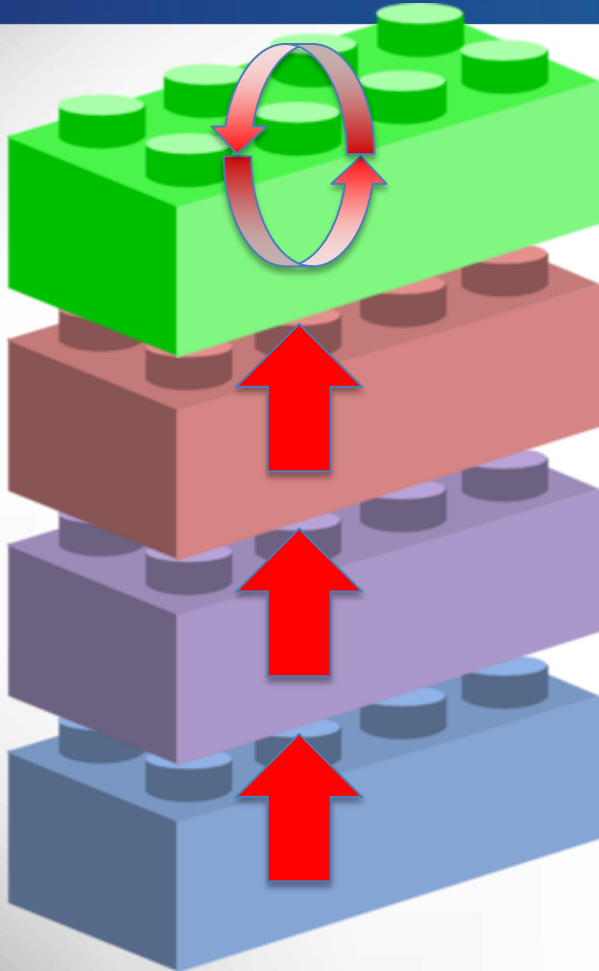
External Issues

- **Rising penetration** of DG Solar
- **Customers** want **choice & control**
- **Internet of Things** drives connectivity to all things
- Shift to more **distributed functions & advanced analytics**
- Heightened need for cyber **security & privacy**

Utility Industry Issues

- Need for **new control mechanisms** (smart inverters, energy storage, solid state transformers)
- Vendor **lock-in** with **proprietary solutions**
- Too much middleware/ **high integration complexity/cost**
- **Underutilization of data** and analytics to identify issues, predict opportunities

BUILDING BLOCKS FOR THE GRID OF THE FUTURE



DATA COLLECTION AND ANALYSIS: unstructured, and structured data, “what-if” analytics, and business intelligence tools.

DATA SECURITY: focuses on architecture and design to ensure all components, systems, and data are secure against cyber attacks, damage, and unauthorized access

DATA ANALYTICS: Unlock data using field message buses and a common semantic structure hosted on a nodal-design to enable data storage and usage anywhere throughout the grid, cloud, or customer premise.

Build GOF Test Bed: 1 common test area (1 substation + associated circuits) with

- Fully sensed (AMI meters, weather, line sensors, PMU, PQM, PDM, in-premise load monitor)
- Enhanced control (battery, switch, recloser, capacitor, inverter)
- Customer assets (PV, EVSE, smart appliances, advanced DR)

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QUESTIONS



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