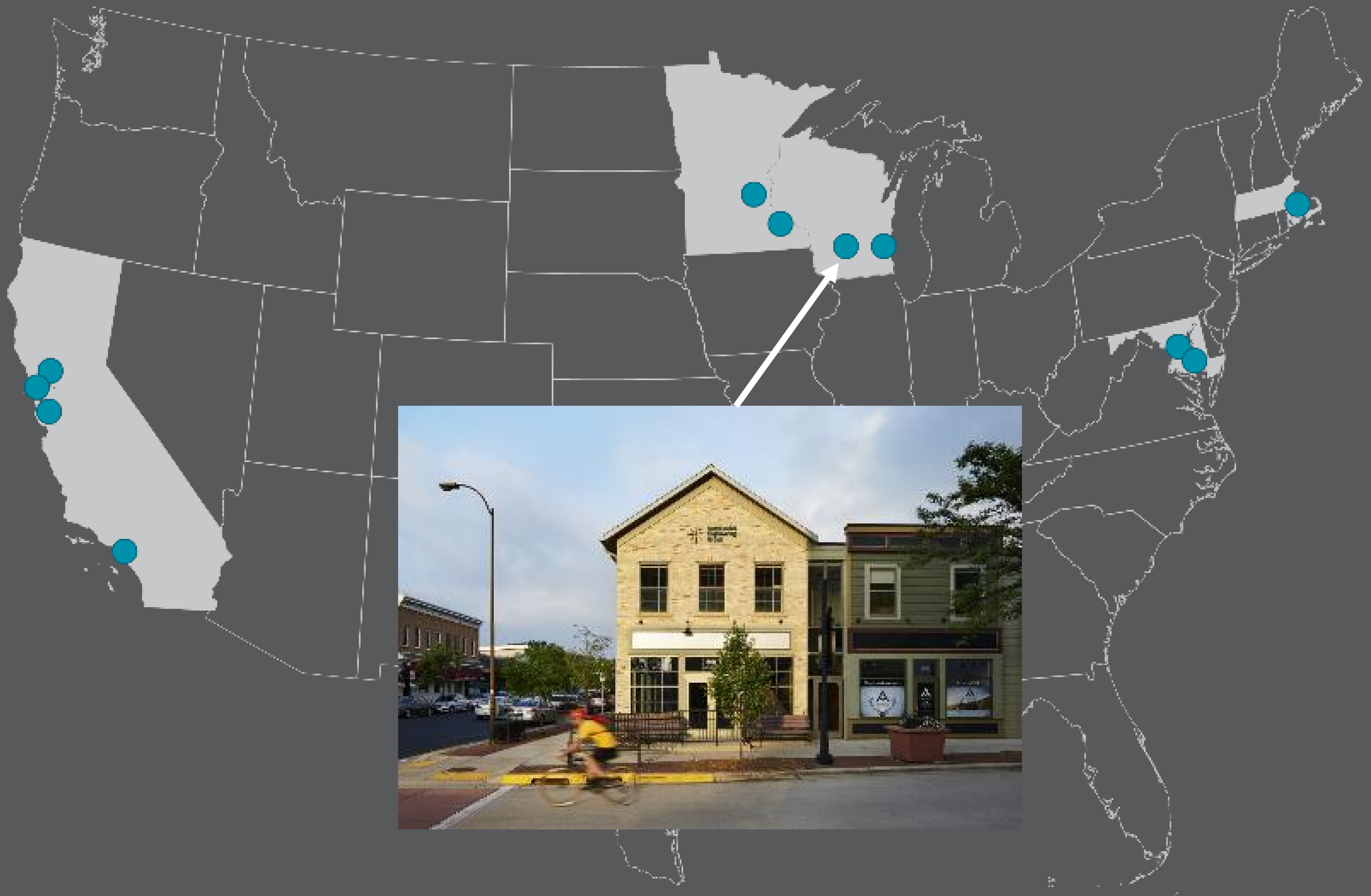
DESIGN AND CONSTRUCTION OF A NET ZERO ENERGY SCHOOL

OREGON SD: FOREST EDGE ELEMENTARY

Show and Tell to WiDRC – Wisconsin Distributed Resources Collaborative
October 15, 2020

MINNEAPOLIS   ROCHESTER   MADISON   MILWAUKEE   WASHINGTON D.C.   ALEXANDRIA   BOSTON   LOS ANGELES   SAN JOSE   SAN FRANCISCO   SAN JOSE

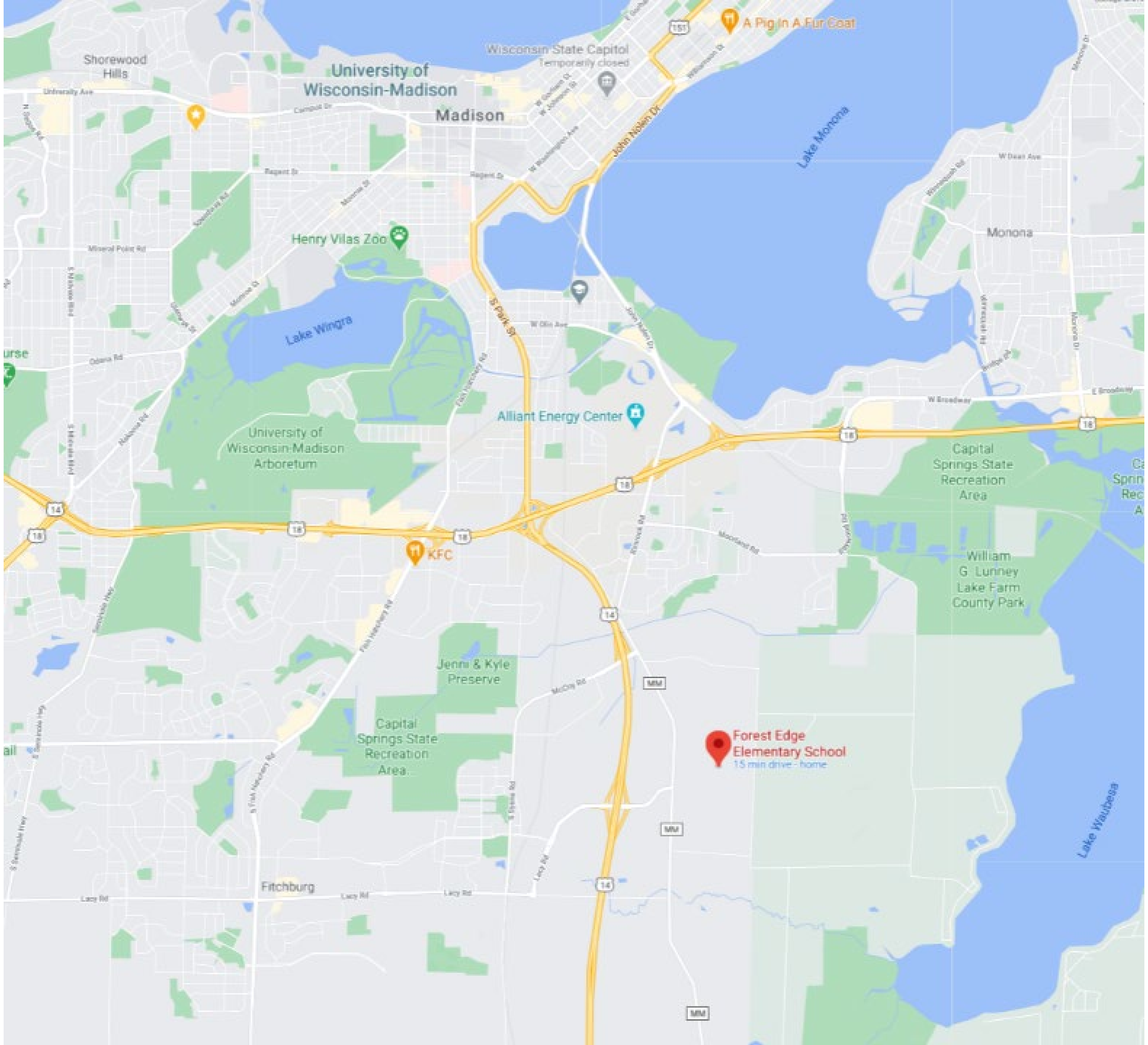


ENGINEERING | ENERGY + INFRASTRUCTURE | LANDSCAPE ARCHITECTURE | SUSTAINABLE DESIGN | DESIGN INSIGHT GROUP (DIG) | DIGITAL PRACTICE GROUP

Why a Net-Zero Energy School?

OREGON SCHOOL DISTRICT

Andy Weiland
OSD Business Manager
Project Champion


University of Wisconsin-Madison
Madison
Wisconsin State Capitol
Temporarily closed
A Pig In A Fur Coat
Shorewood Hills
Lake Monona
Monona
Henry Vilas Zoo
Lake Wingra
Alliant Energy Center
University of Wisconsin-Madison Arboretum
Capital Springs State Recreation Area
William G. Lunney Lake Farm County Park
KFC
Jenni & Kyle Preserve
Capital Springs State Recreation Area
Forest Edge Elementary School
15 min drive · home
Lake Waubesa
Fitchburg
Lacy Rd
John Nolen Dr
S Park St
W Olin Ave
W Broadway
E Broadway
Moorland Rd
Regent St
Monroe St
Campus Dr
Mineral Point Rd
Odana Rd
McCoy Rd
S Fish Hatchery Rd
14
18
151
MM

https://www.youtube.com/watch?v=N7TQin-OZIs&feature=youtu.be

NZE Project Team

HGA

OREGON SCHOOL DISTRICT

bray architects

Findorff
BUILDERS SINCE 1890

Schneider Electric

MUERMANN ENGINEERING
A DIVISION OF MSA

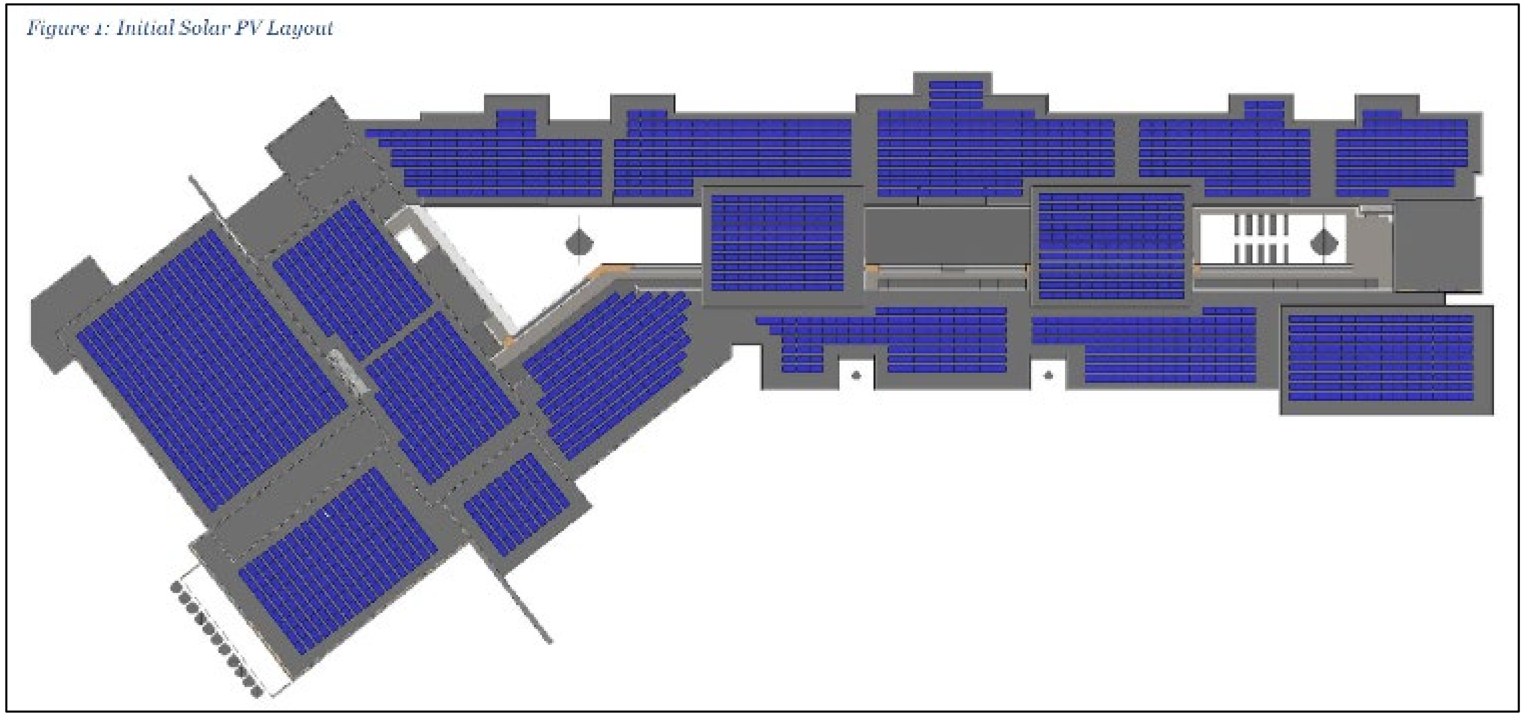
Electric Construction inc

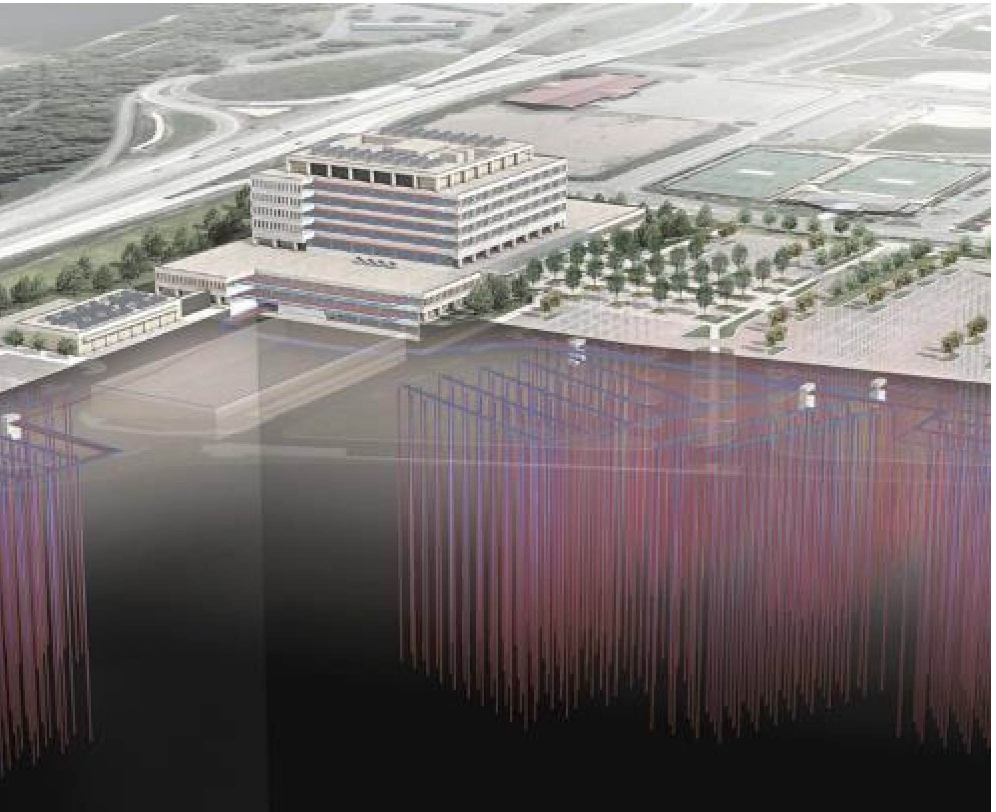
ALPHA controls & services

FREDERICKSEN Engineering

FULL SPECTRUM SOLAR

SURE FIRE

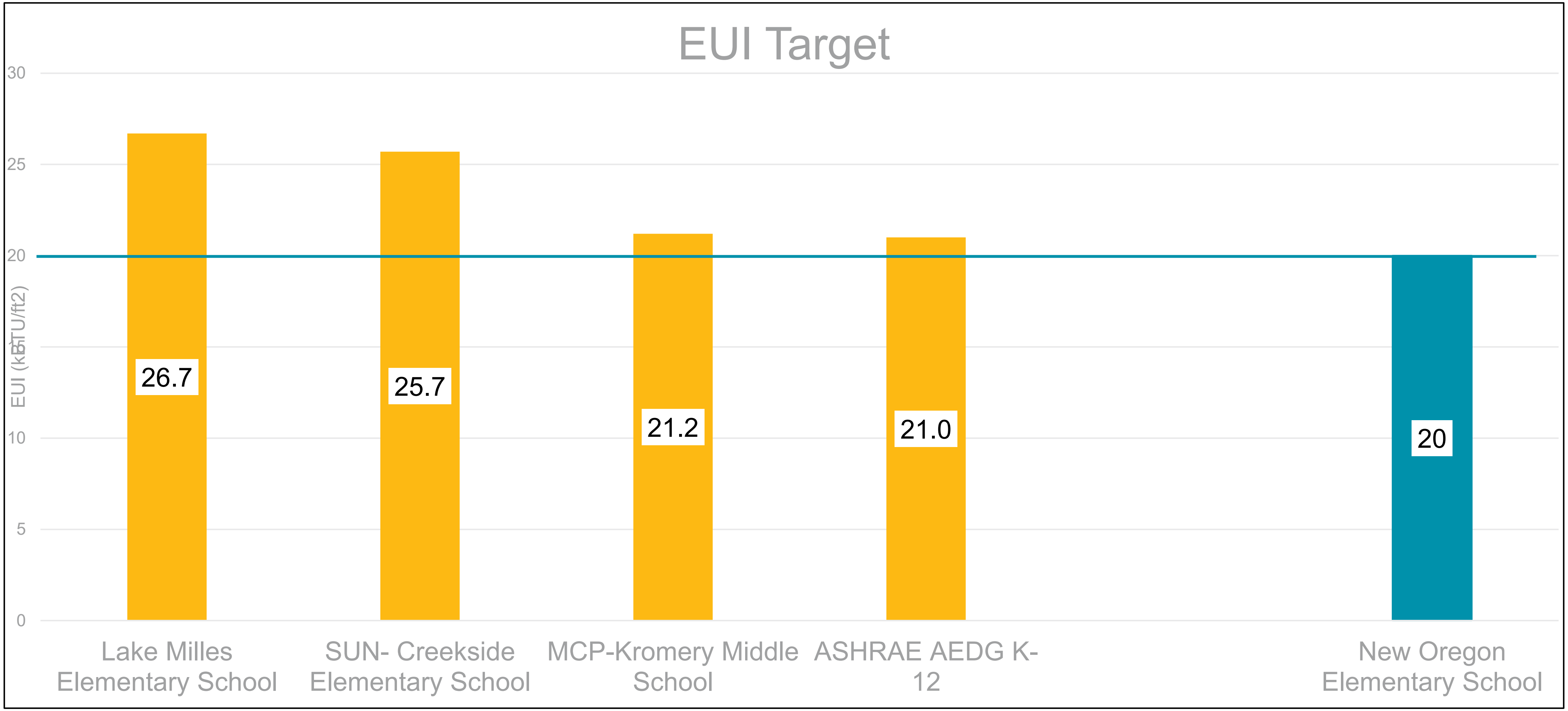




HGA's Project Roll

- Energy Modeling
- Geothermal, PV and Battery design
- Commissioning
- Measurement and Verification

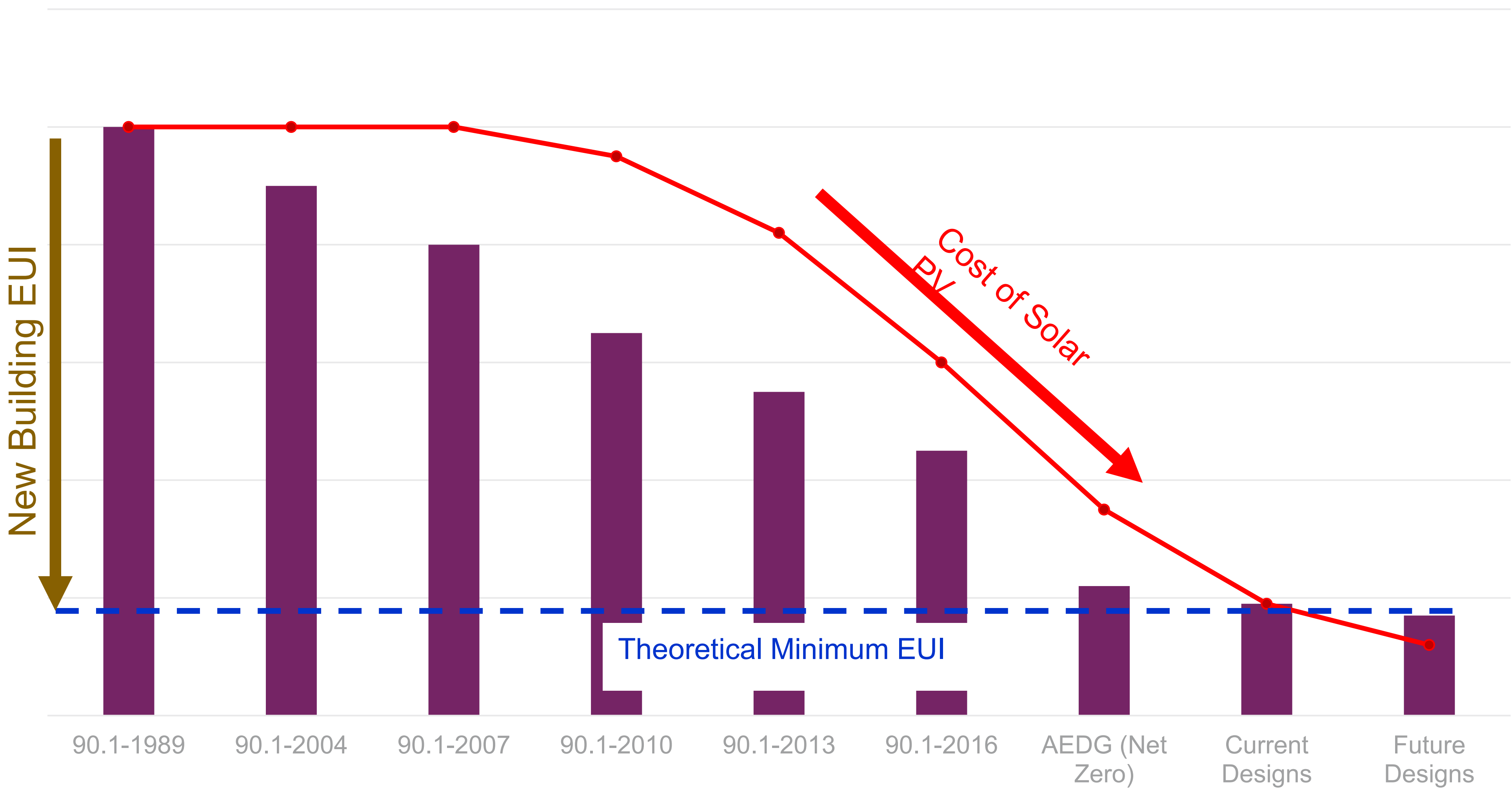
Design Process: EUI Target



Past Modeling Results

Project	Design Modeled Data (kBTU/SF)	Actual Utility Data (kBTU/SF)	Accuracy
Waunakee MS	29	25.5	88%
Kromery MS	21	19.3	92%
Creekside ES	24.1	23.5	98%
Horizon	24.1	23.5	98%
Lake Mills MS	34.5	29.1	84%
Lake Mills ES	26.7	26.7	100%
		Average:	93%
Oregon ES- NZE	23.3	????	????

Trends in Energy Efficiency and Cost of Solar



NZE: Consumption (EUI) vs. Production (Solar)

- 30 kBTU Target - Less Energy Efficient, Less First Cost

  - Huge Solar PV, High First Cost

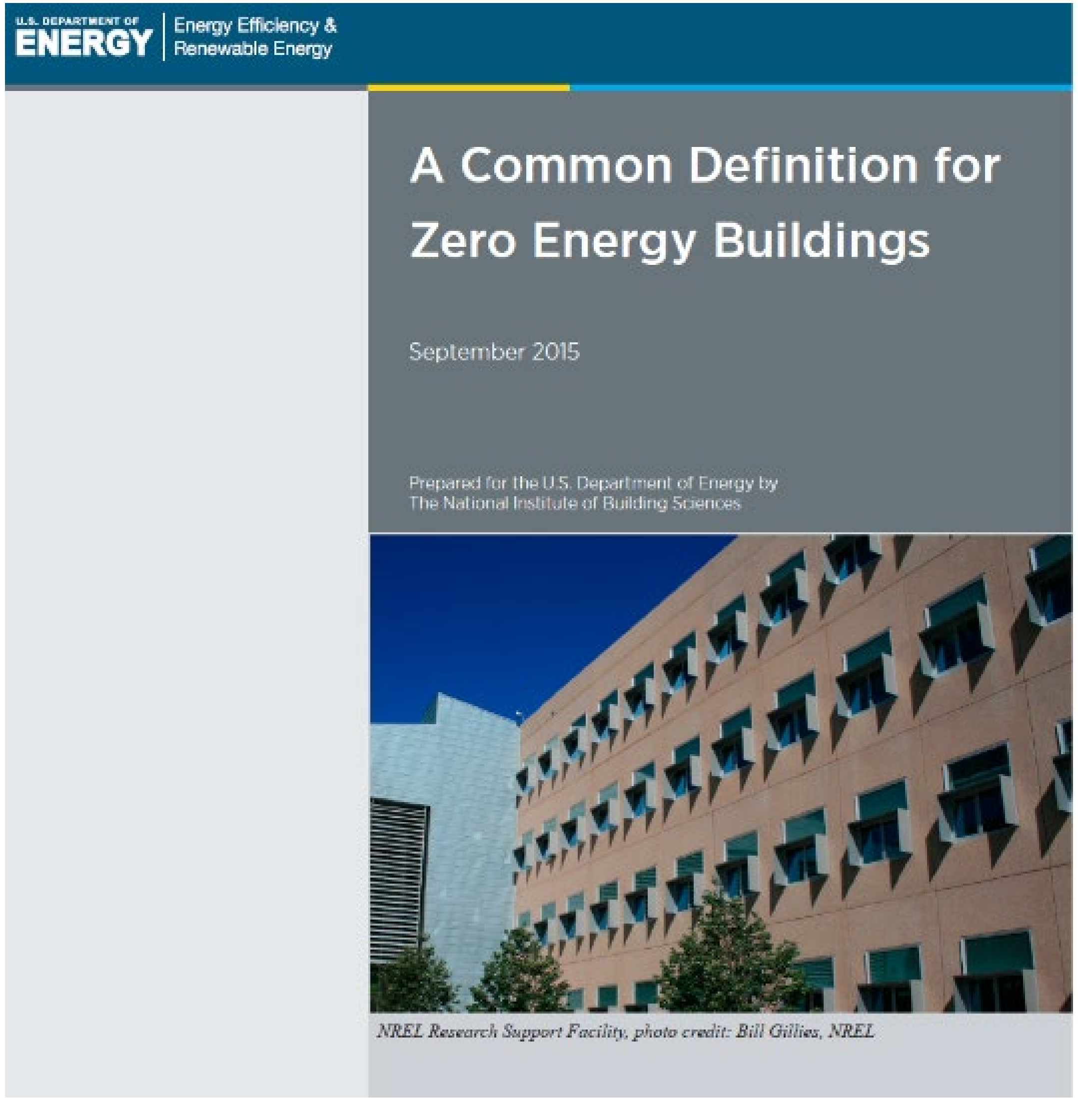
- The sweet spot for NZE and minimal first cost is somewhere in between
- How do we find this sweet spot EUI target
  - Mostly through energy modeling and collaboration with project team

- 15 kBTU Target - Extreme Energy Efficiency, High First Cost

  - Less Solar PV, Less First Cost

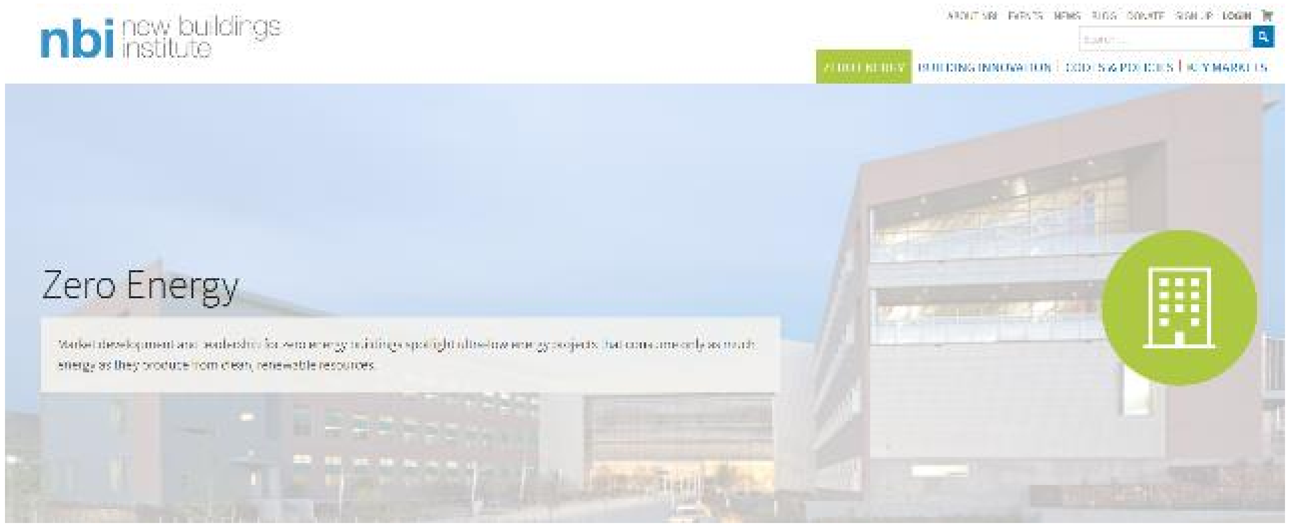
Key Ingredients for NZE

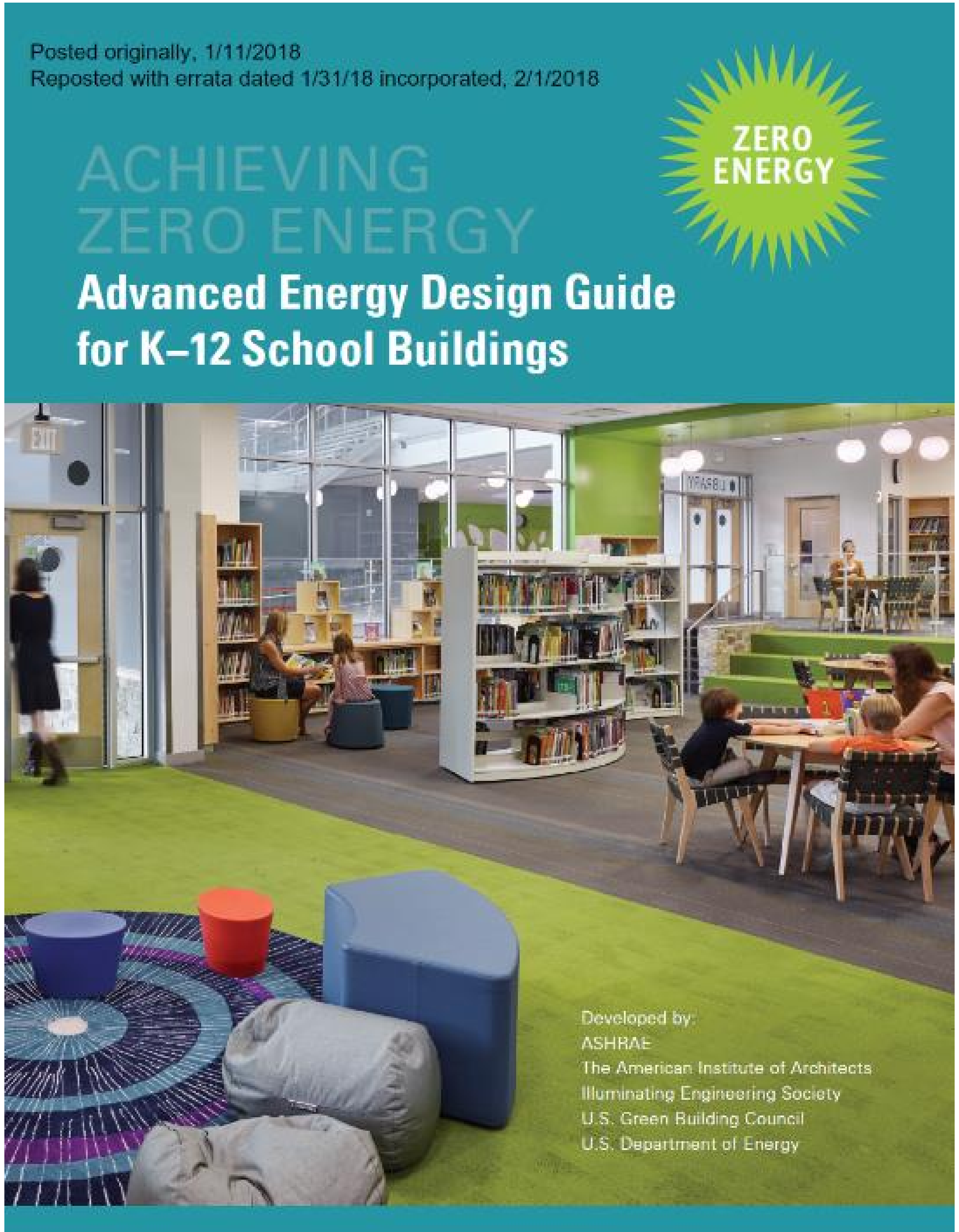
- Geothermal (ground source) HVAC
- Solar PV Covering Roof
- High performance envelope
- Aggressive lighting control
- Rigorous commissioning
- Operational excellence



Great Resources

- ASHRAE NZE Design Guide
- New Buildings Institute (NBI)

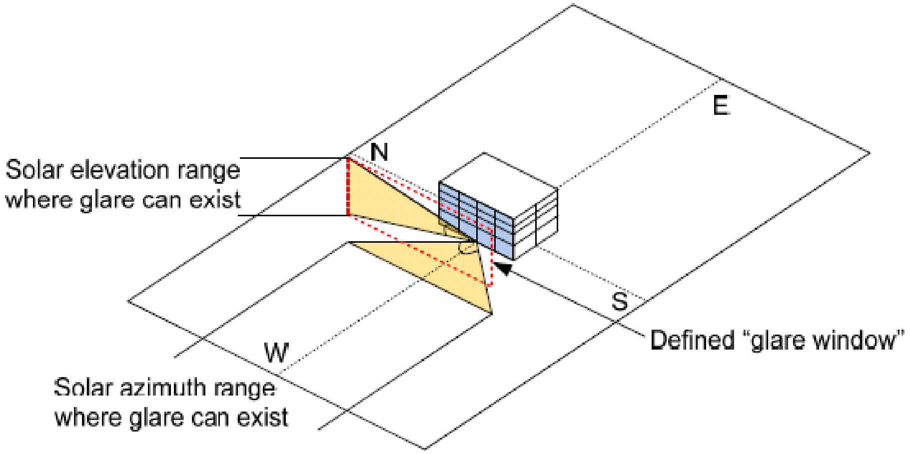




Interesting Design Elements

- Green bond
- No natural gas connection
- Electrochromic lighting
- ECM motor pump skid for geo pumps
- Submetering of loads
- Solar PV roof
- Advanced lighting control

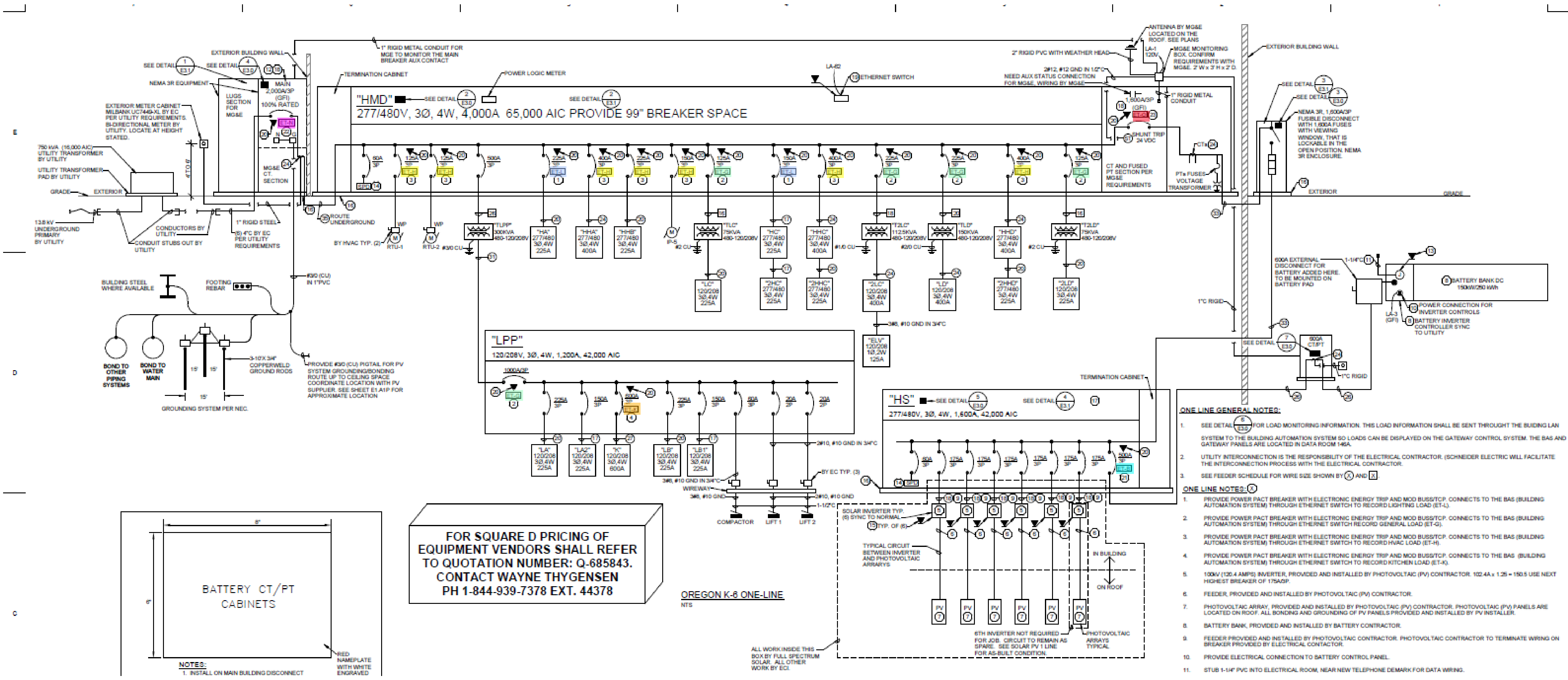
Interesting Design Elements



Interesting Design Components

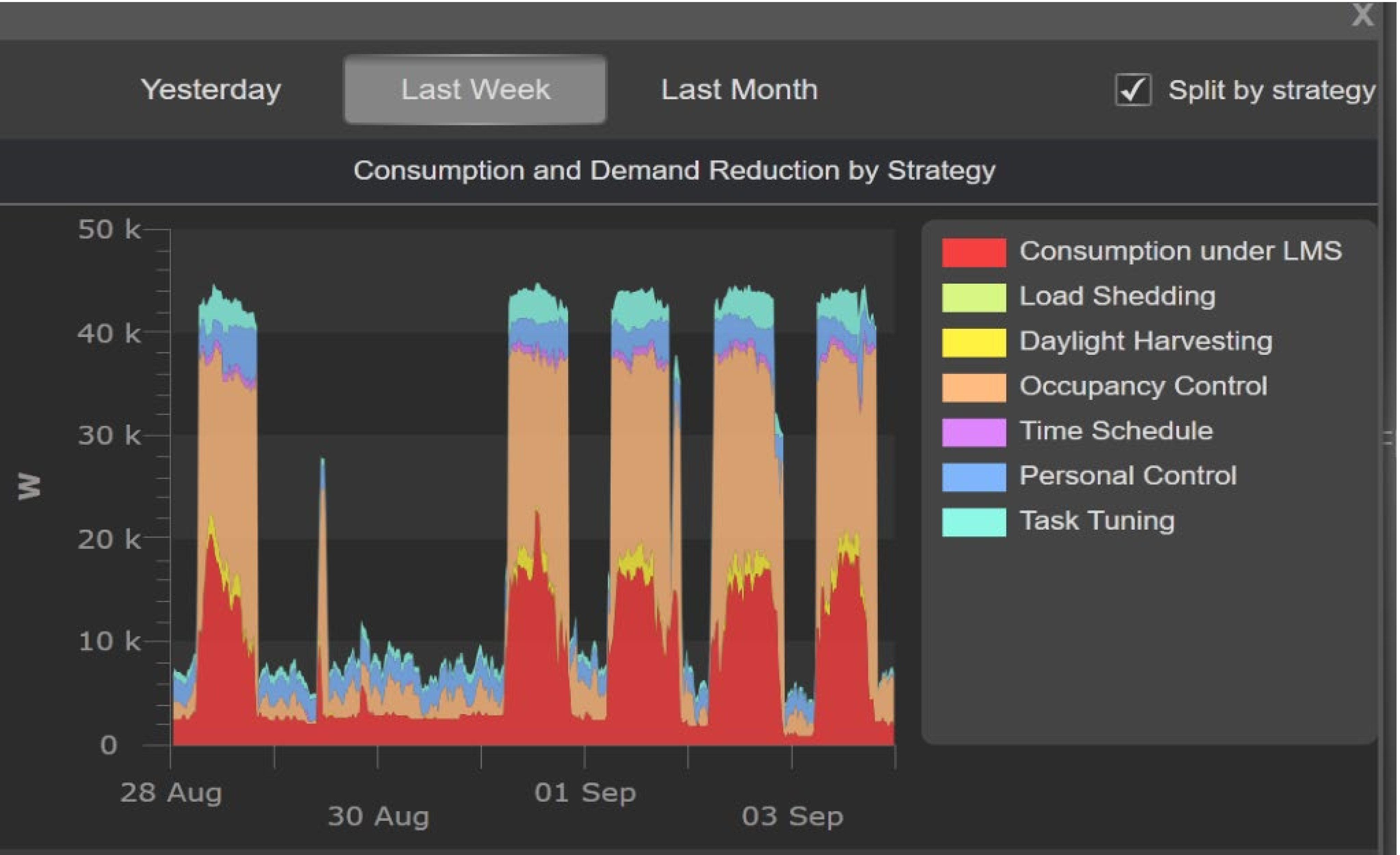

Power - Chart
Save
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Power
0.4 kW
10/10/2020 11:34:55 PM
06:00 PM
08:00 AM
10:00 PM
12:00 PM
02:00 AM
04:00 PM
06:00 AM
08:00 PM
10:00 AM
12:00 AM
02:00 PM
Oct 05, 2020
Oct 12, 2020
Power (kW)

Interesting Design Elements



Interesting Design Elements

Interesting Design Elements

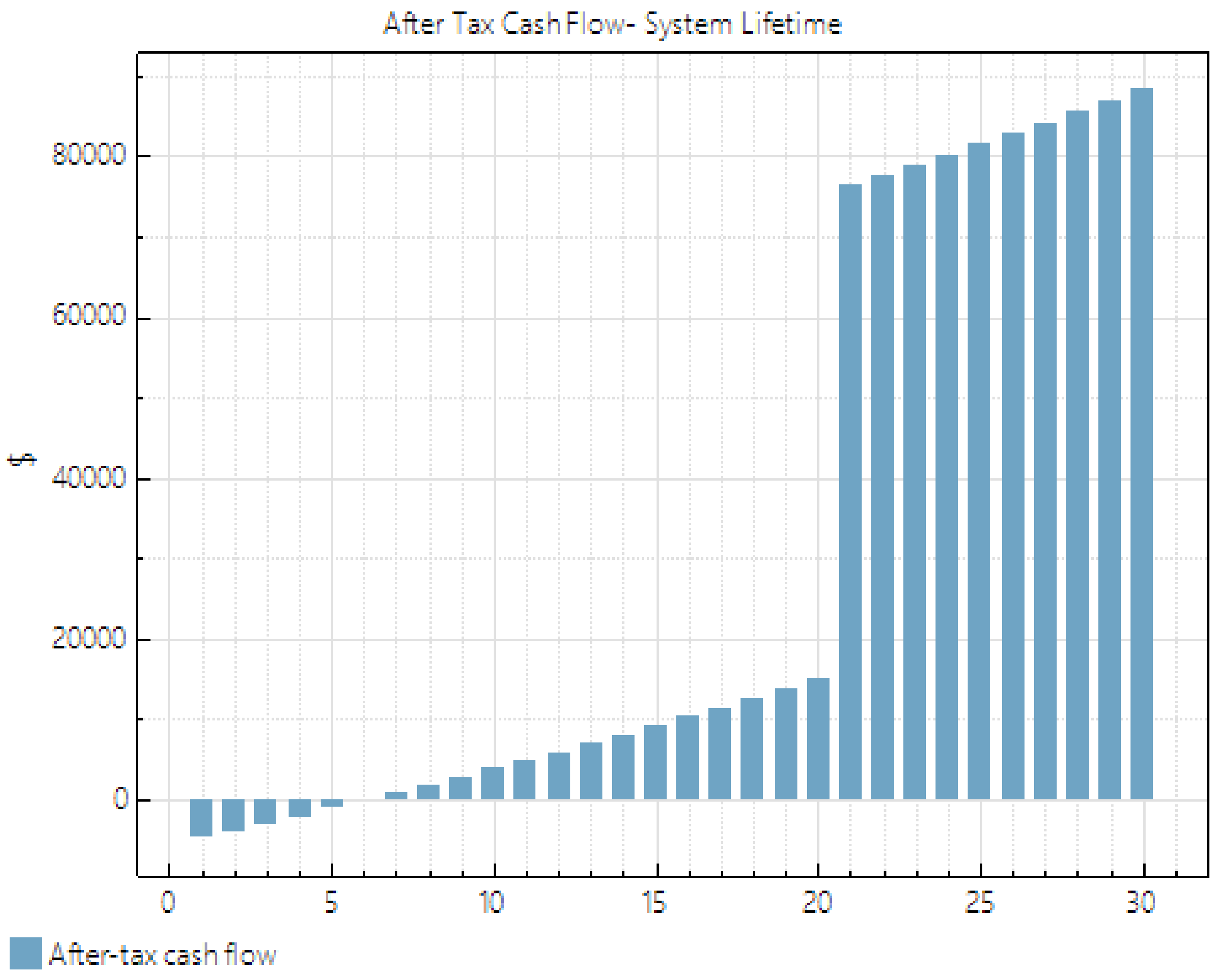


Challenges

- Extent of glazing
- Interconnection costs
- Microgrid integration
- Controls integration
- COVID-19

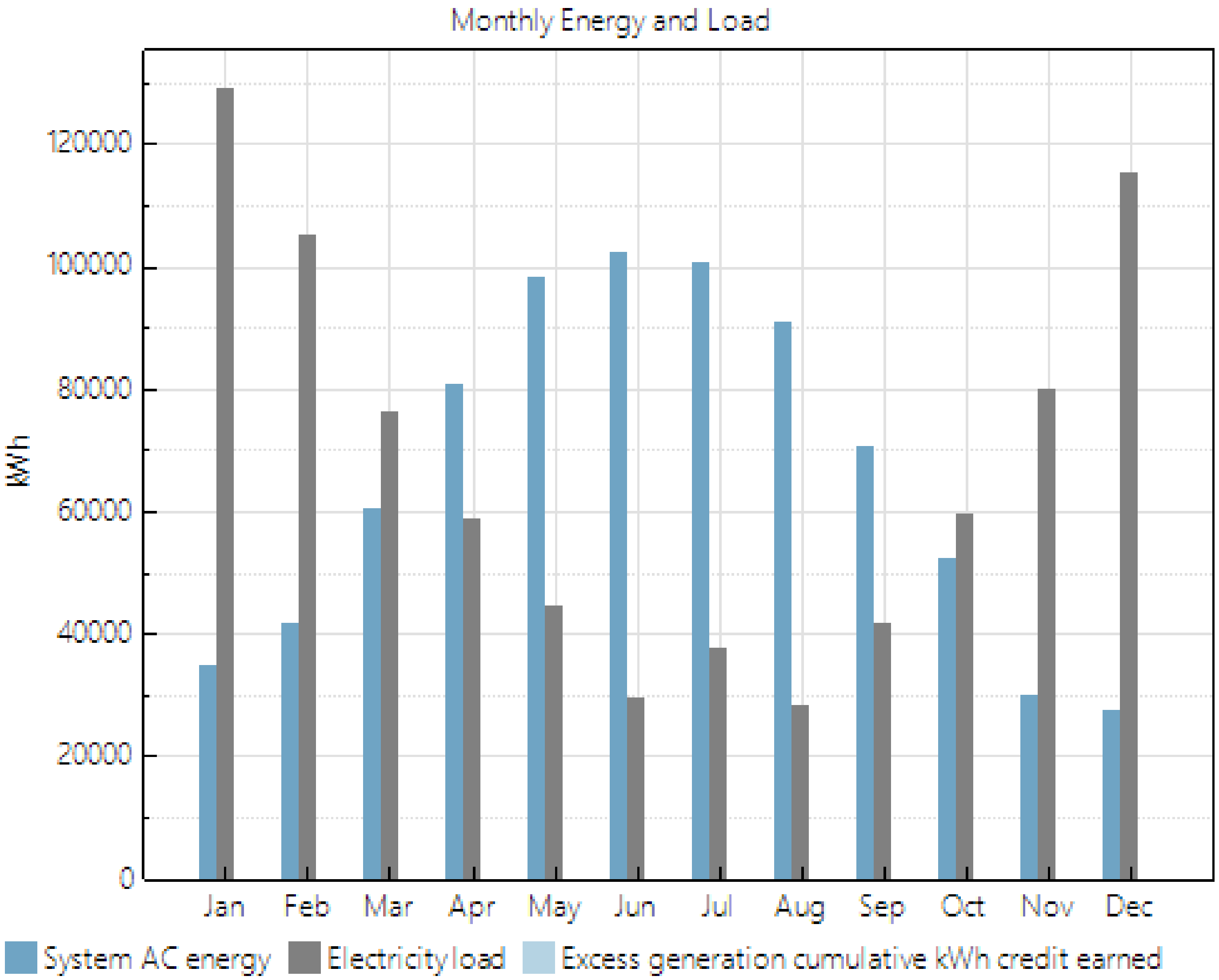
PV Economics

- 14 year simple payback
- $1.45/W installed



Battery Goals

- Reduce peak charges
- Self consume more solar PV
- Include microgrid capability
- Allow for future flexibility
- Limitations: long term storage



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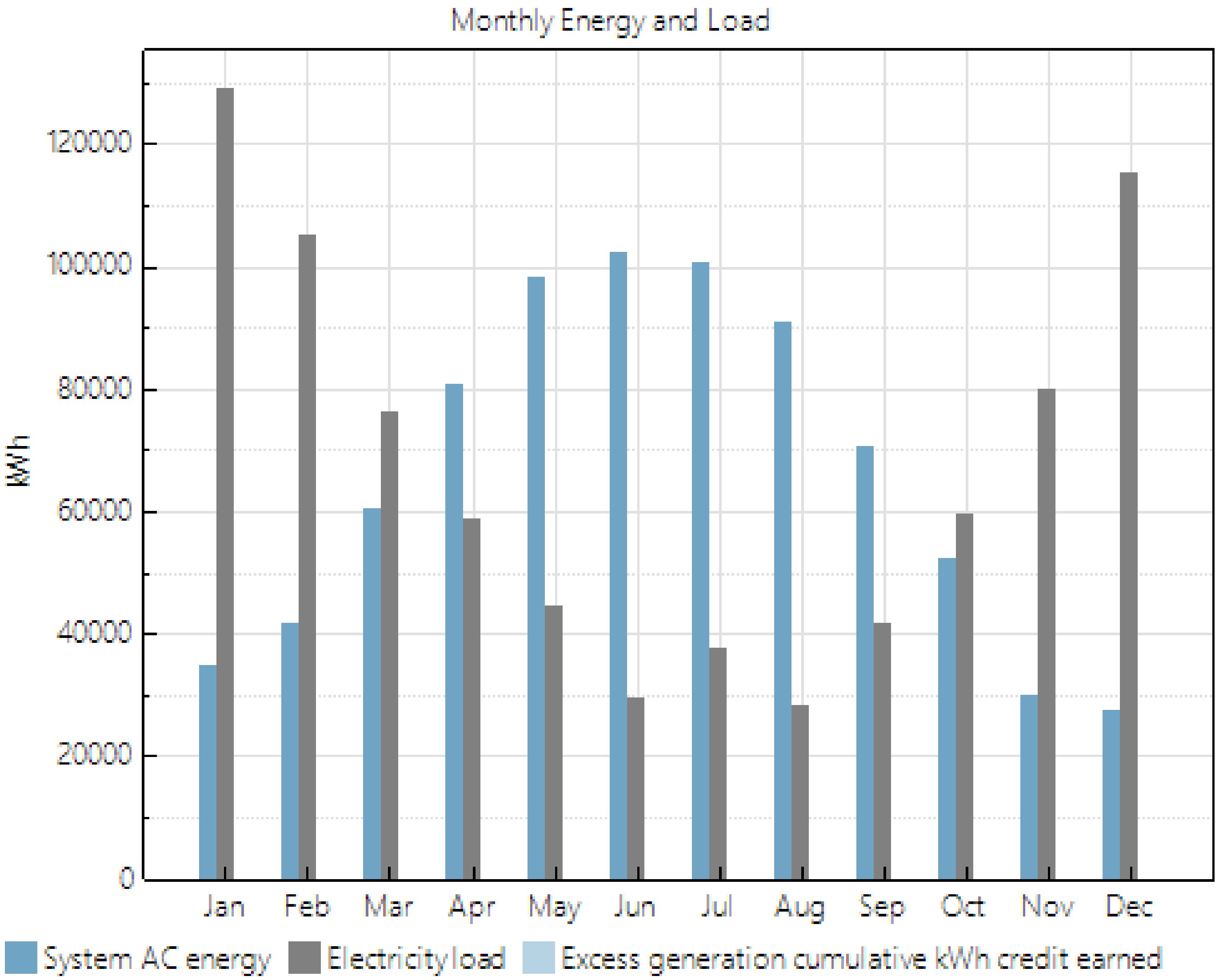


Battery Use Cases

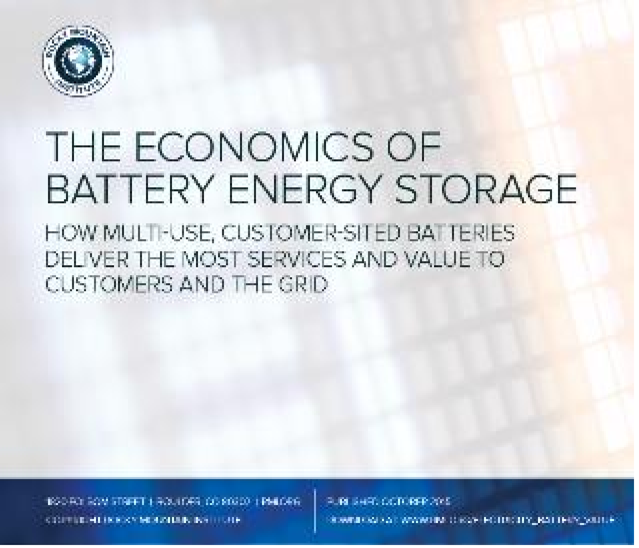
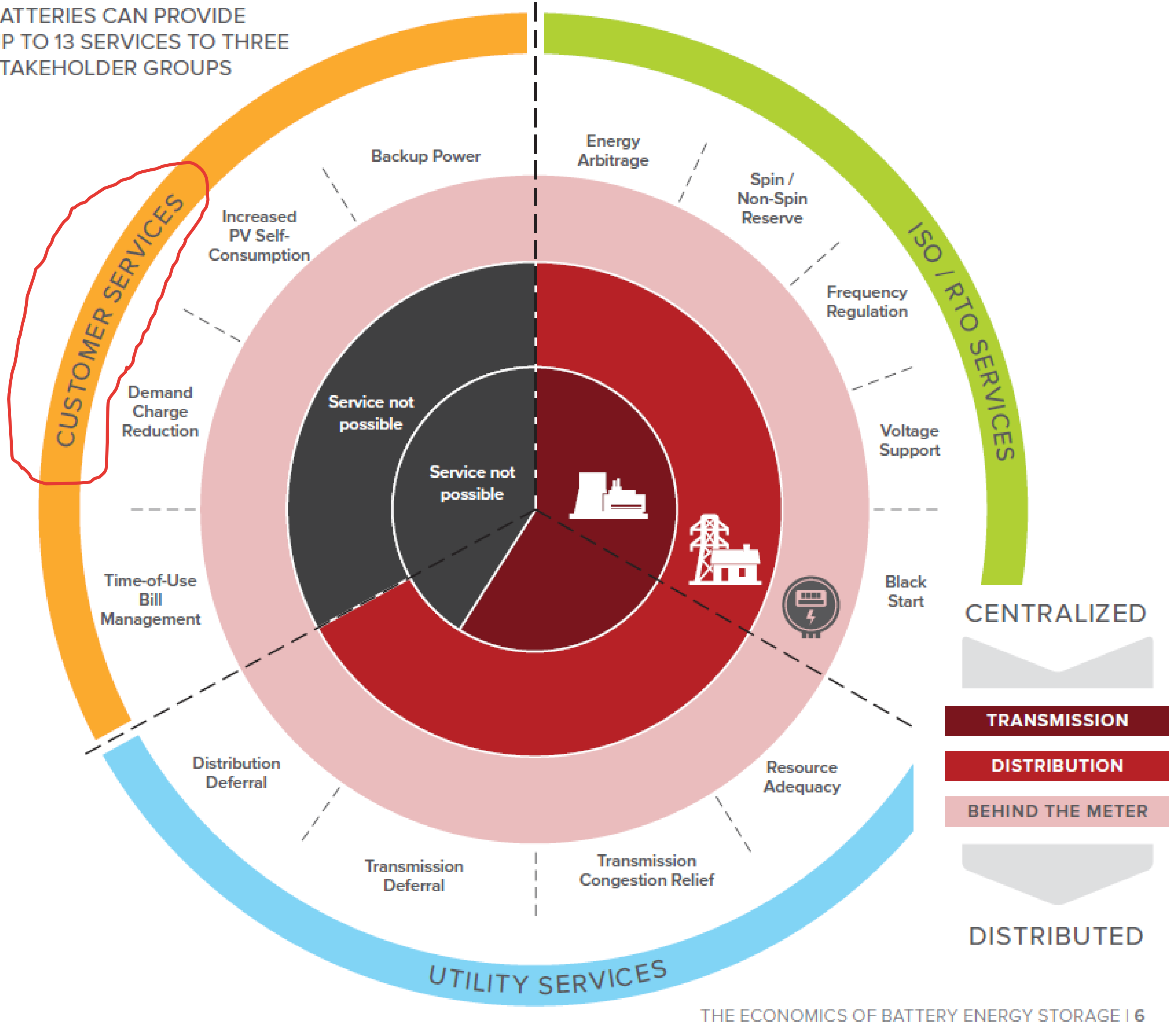
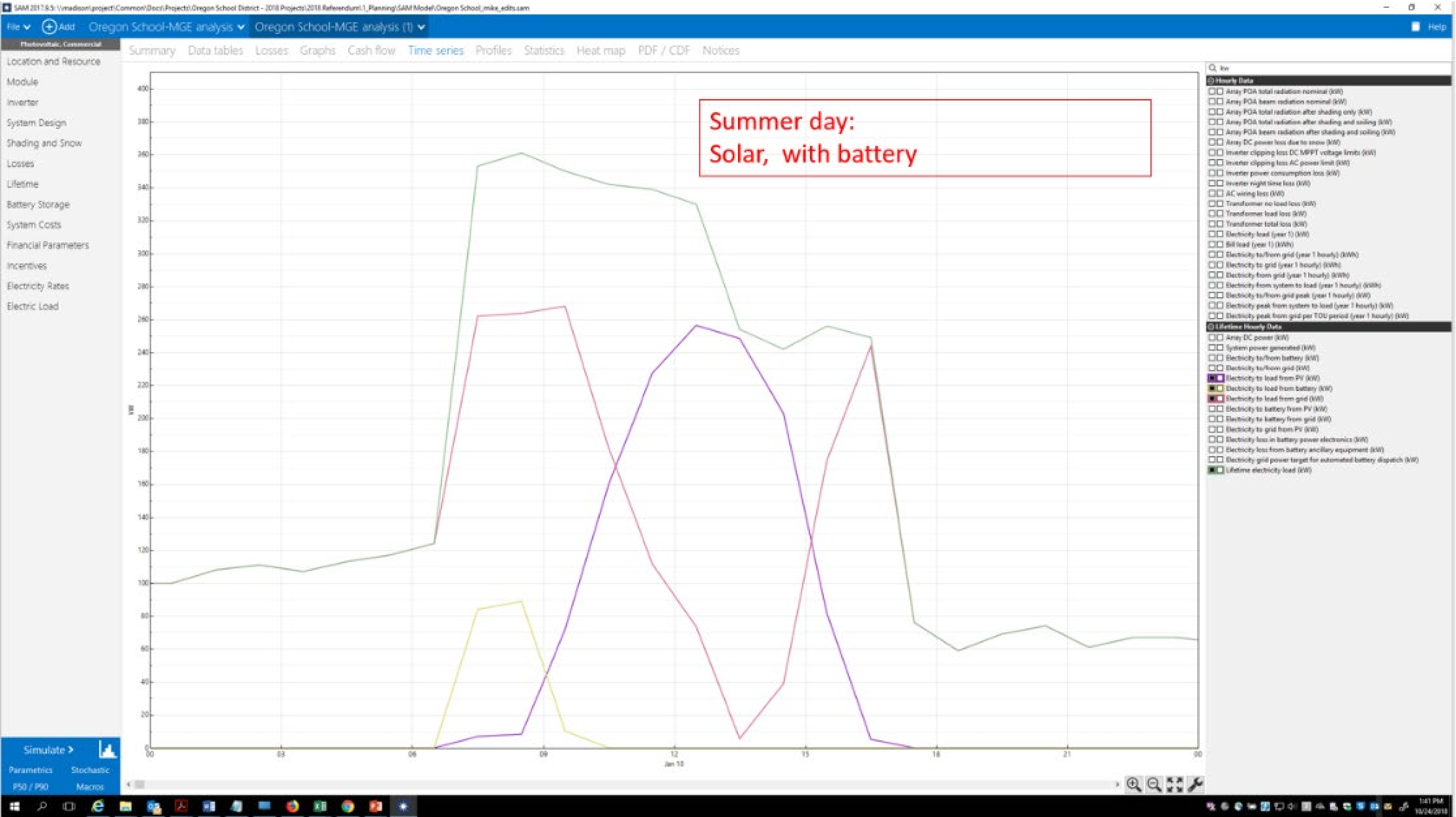


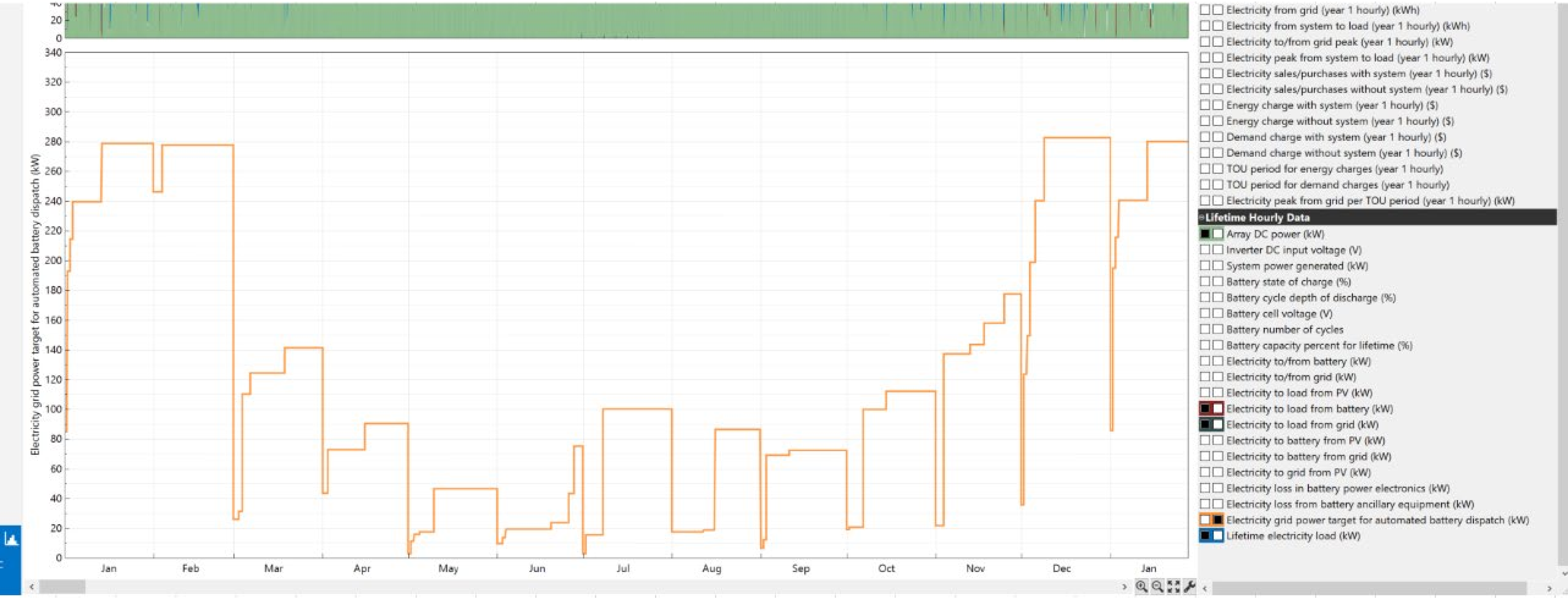
FIGURE ES2
BATTERIES CAN PROVIDE UP TO 13 SERVICES TO THREE STAKEHOLDER GROUPS



Battery Feasibility



Battery Feasibility



Battery Sizing Process

at 600kW PV size								
Desired bank capacity (kWh)	**Desired bank power (kW)**	**Annual AC energy gross (kWh/yr)**	**Net present value ($)**	**Nominal LCOE (cents/kWh)**	**Payback period (years)**	**Real LCOE (cents/kWh)**	**Electricity bill savings with system (year 1) ($/yr)**	**Net capital cost ($)**
100	50	772,085	165,549	9	13	7	65,673	1,116,690
150	75	772,085	162,373	9	13	7	67,972	1,141,460
200	100	772,085	152,162	9	13	7	69,841	1,166,800
50	25	772,085	144,906	9	14	7	61,818	1,091,360
300	125	772,085	125,619	10	14	8	72,168	1,216,330
0	0	772,085	92,687	9	14	7	57,613	1,066,590
400	200	772,085	78,738	10	14	8	72,907	1,266,440
500	250	772,085	39,509	10	15	8	73,044	1,316,540
600	300	772,085	5,085	11	15	9	73,911	1,366,640
700	350	772,085	-31,016	11	15	9	73,187	1,416,750

Battery Procurement

- Performance spec for 125kW/250kWh
- Pricing near $800/kWh
- Most bids disqualified for not meeting design requirements (primarily software/control)

Selected System

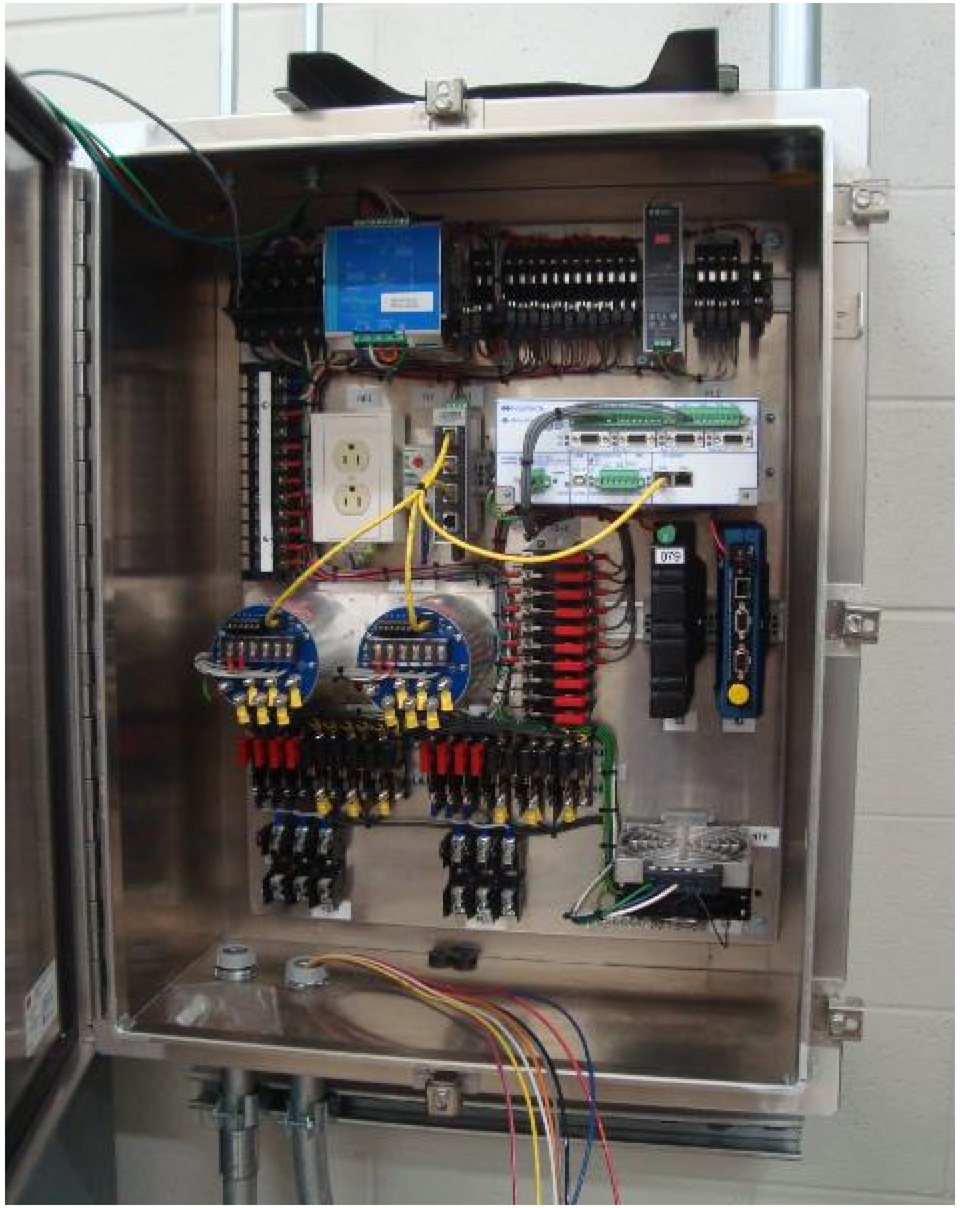
- Schneider with LG Chem Batteries
- Delivered 10/14
- Commissioning begins end of October

125 kW/250 kWh system

Solar / Battery Interconnection Process

- Initial submission December 2019
- Conditional approval July 2020
- Distribution study $20k
- Remote monitoring and disconnect $35k

MGE Monitoring Box



- CTs and PTs in the 1600A switchboard to monitoring the total net generation of both the solar and the battery.
- CTs and PTs for the 600A battery
- MGE owned monitoring box, which includes the following:
    - Wires to each set of CTs and PTs
    - Shunt trip to the 1600A generation breaker
    - Status wires of the 1600A generation breaker
    - Status wires of the 2000A main breaker
    - Communications wire to the roof
    - Radio antenna on the roof
- Labor to build, install, test, and commission the monitoring and trip setup.

Solar Inverters

MGE’s Interconnection Concerns

- Proper islanding and grid reconnection
- Transient impacts with MGE generation on buss

Utility Engineer: IA Process Recommendations

- Incorporate IEEE 1547-2018 into updated PSC 119
- Allow for more visibility of DER’s to utility

Owner/Engineer Recommendations

- Provide process for cost estimates prior to submission of interconnection application
- Include battery requirements into PSC 119
- Establish common interconnection standards among all utilities for batteries and solar

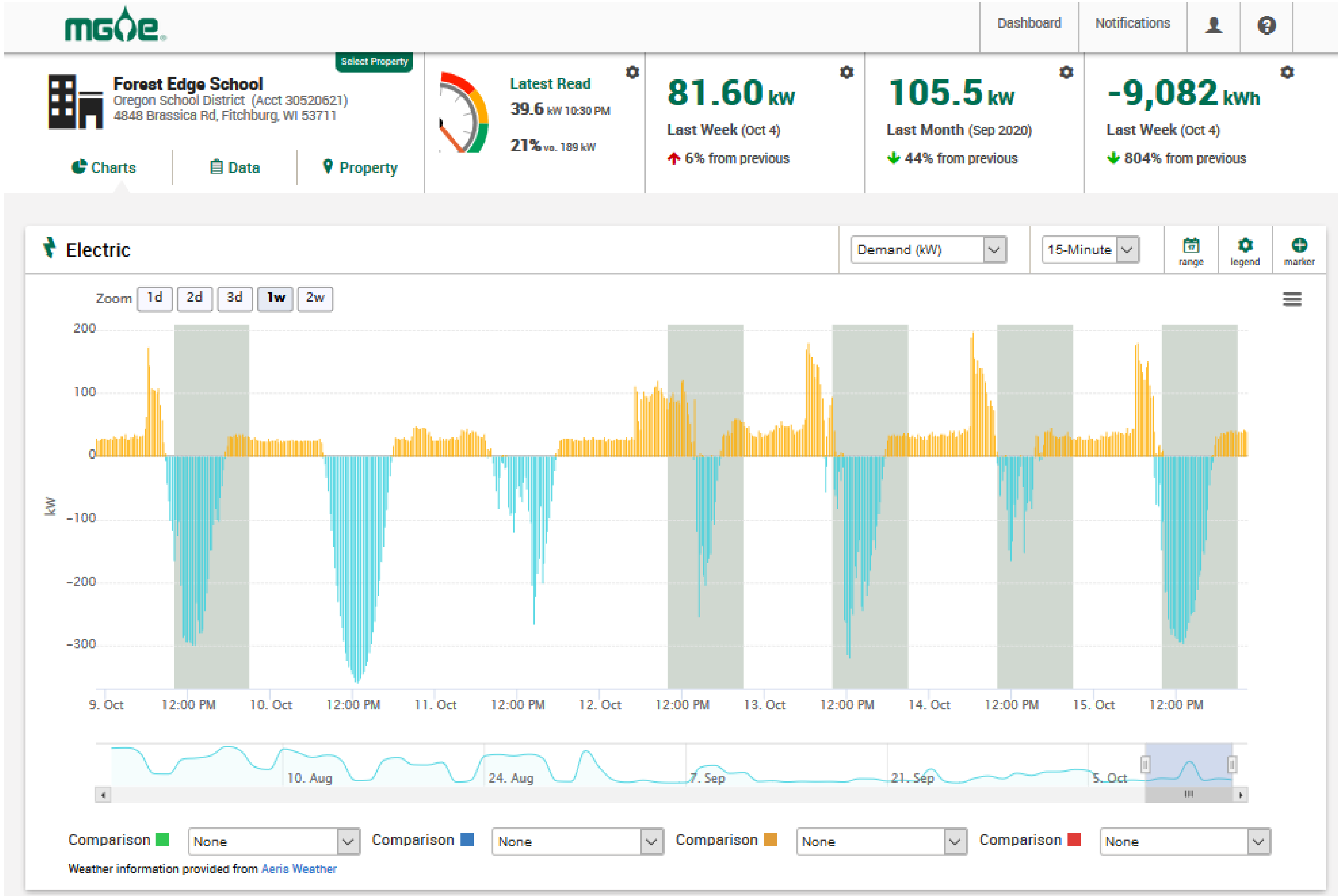

Schneider
Electric



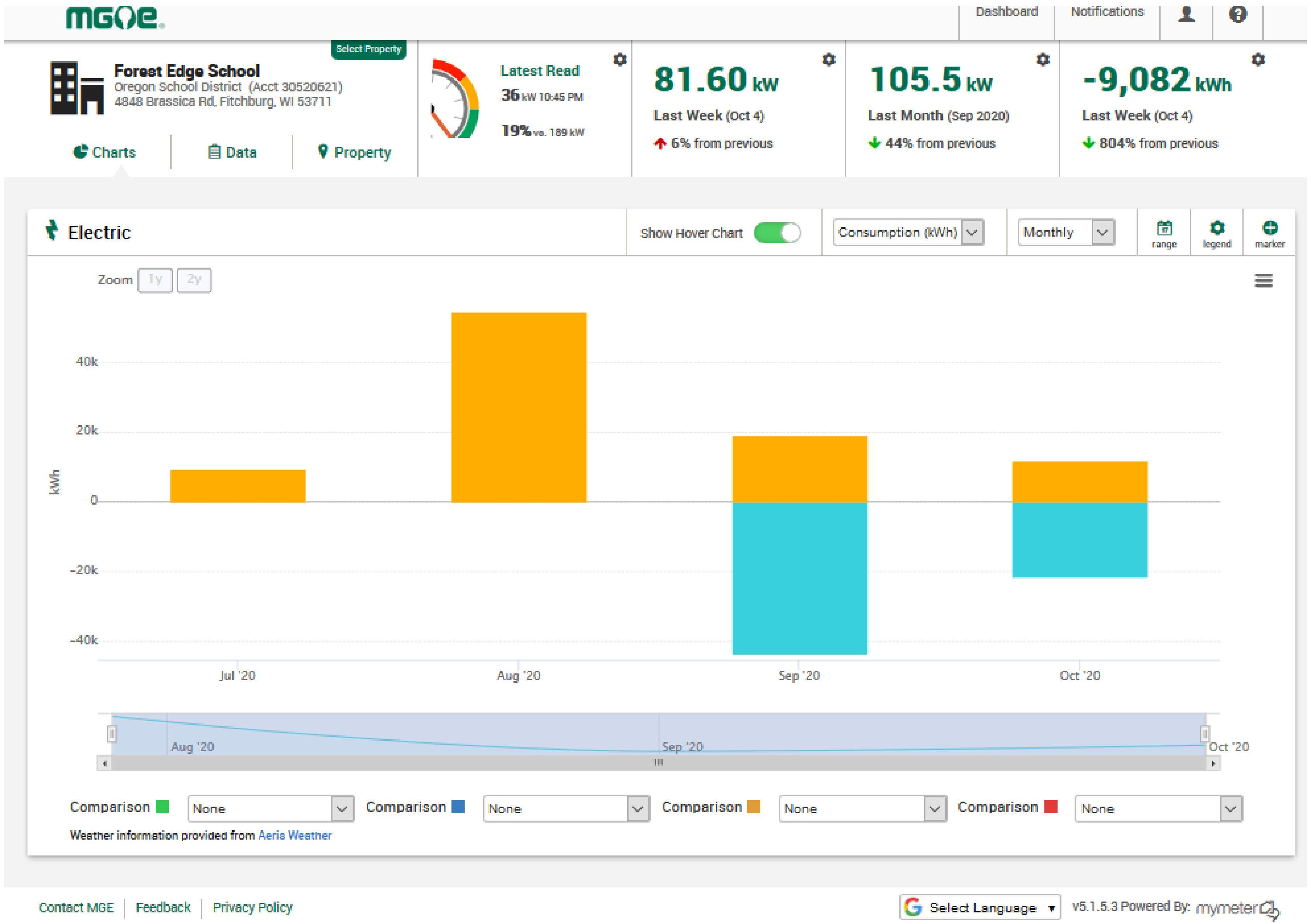
Monitoring Tools

- MGE MyMeter
- SolarEdge Monitoring
- Panel level monitoring
- BESS Monitoring

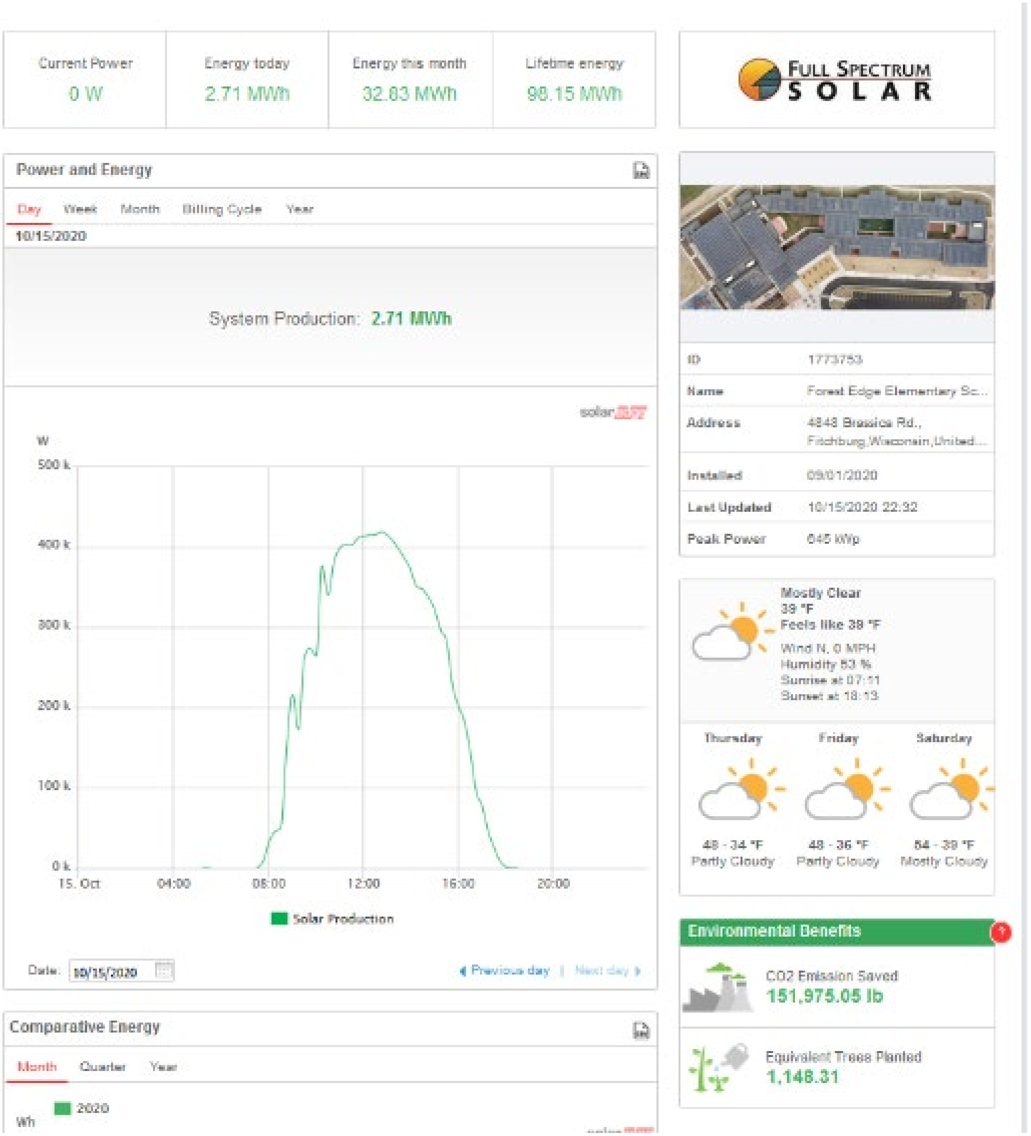
MGE MyMeter


Dashboard
Notifications
Select Property
Forest Edge School
Oregon School District (Acct 30520621)
4848 Brassica Rd, Fitchburg, WI 53711
Charts
Data
Property
Latest Read
39.6 kW 10:30 PM
21% vs. 189 kW
81.60 kW
Last Week (Oct 4)
6% from previous
105.5 kW
Last Month (Sep 2020)
44% from previous
-9,082 kWh
Last Week (Oct 4)
804% from previous
Electric
Demand (kW)
15-Minute
range
legend
marker
Zoom 1d 2d 3d 1w 2w
200
100
0
-100
-200
-300
kW
9. Oct
12:00 PM
10. Oct
11. Oct
12. Oct
13. Oct
14. Oct
15. Oct
10. Aug
24. Aug
7. Sep
21. Sep
5. Oct
Comparison
None
Weather information provided from Aeria Weather

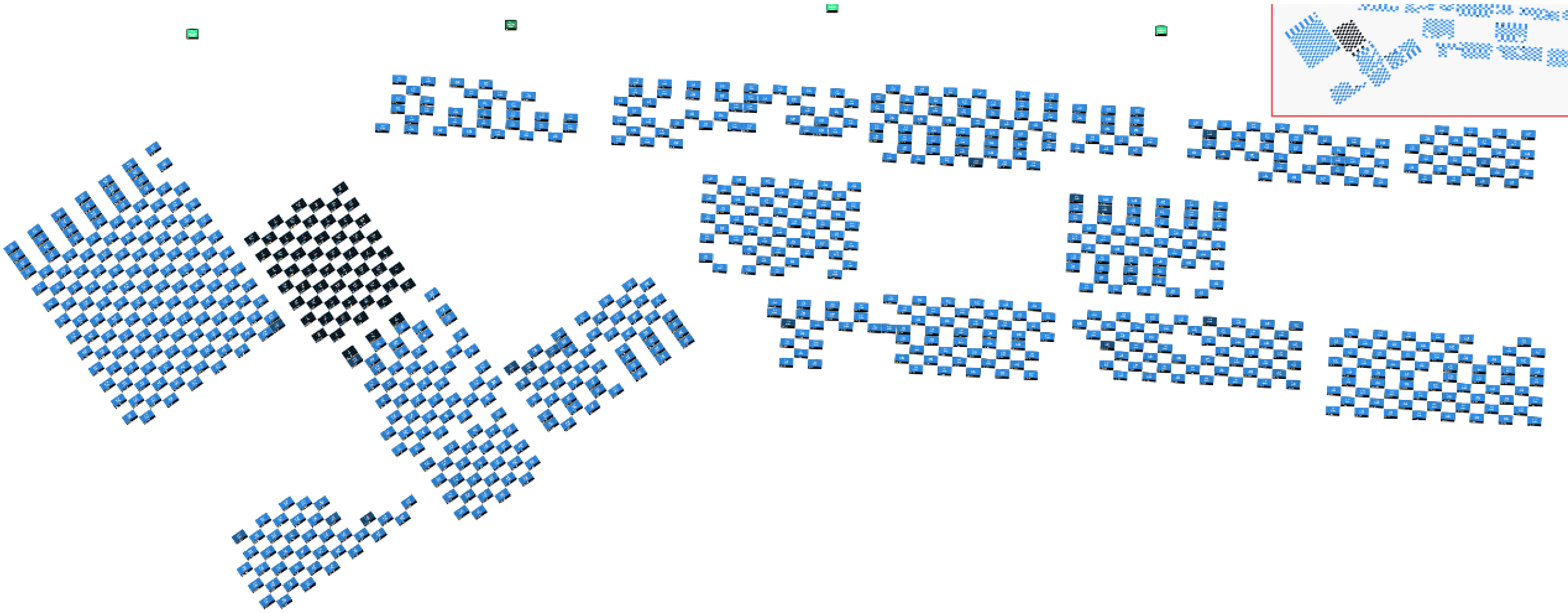
MGE MyMeter


Dashboard
Notifications
Select Property
Forest Edge School
Oregon School District (Acct 30520621)
4848 Brassica Rd, Fitchburg, WI 53711
Charts
Data
Property
Latest Read
36 kW 10:45 PM
19% vs. 189 kW
81.60 kW
Last Week (Oct 4)
6% from previous
105.5 kW
Last Month (Sep 2020)
44% from previous
-9,082 kWh
Last Week (Oct 4)
804% from previous
Electric
Show Hover Chart
Consumption (kWh)
Monthly
range
legend
marker
Zoom 1y 2y
40k
20k
0
-20k
-40k
kWh
Jul '20
Aug '20
Sep '20
Oct '20
Comparison
None
Weather information provided from Aeris Weather
Contact MGE
Feedback
Privacy Policy
Select Language
v5.1.5.3 Powered By: mymeter

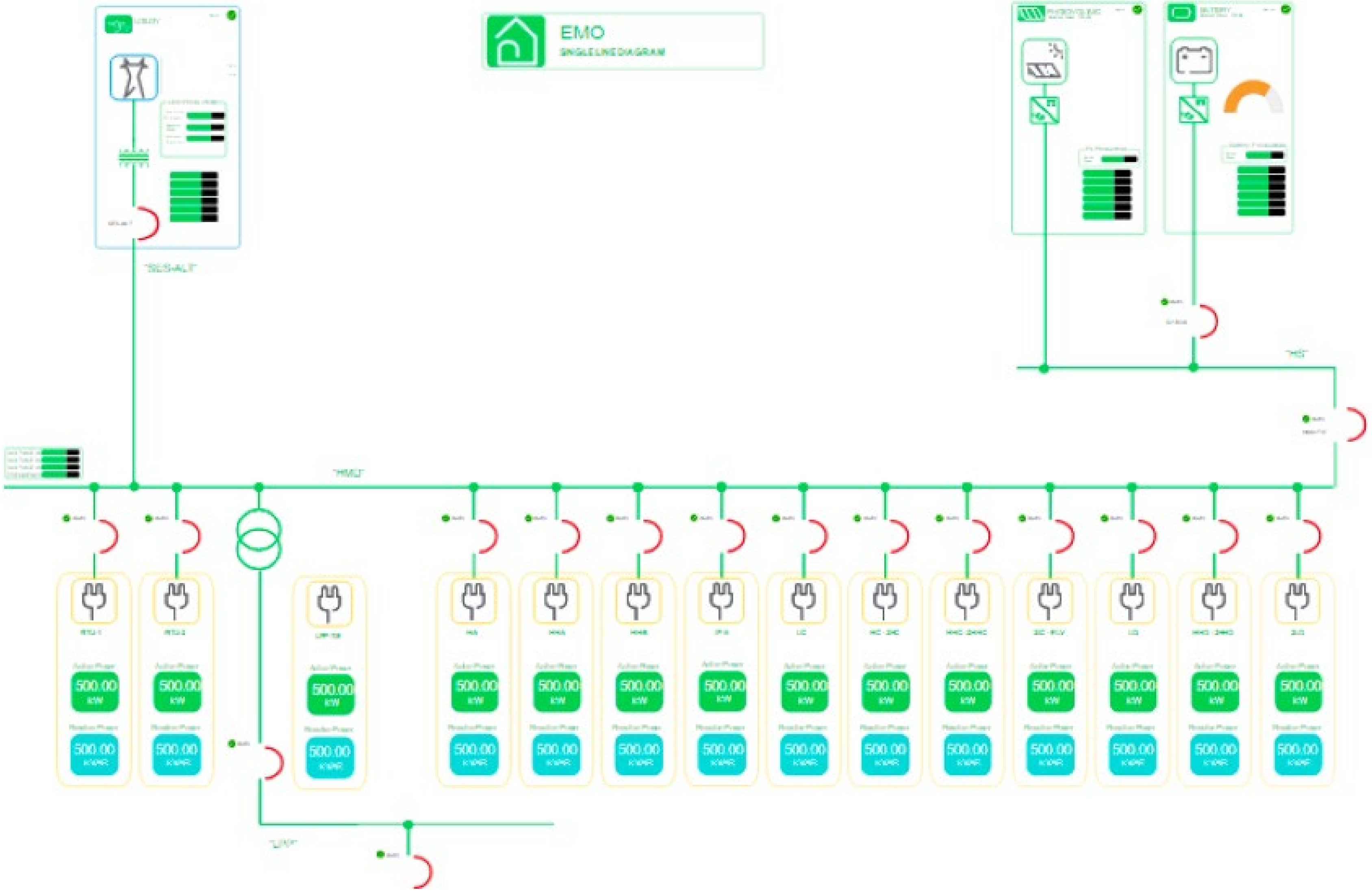
SolarEdge Monitoring



SolarEdge Monitoring



BESS and Panel Level Monitoring



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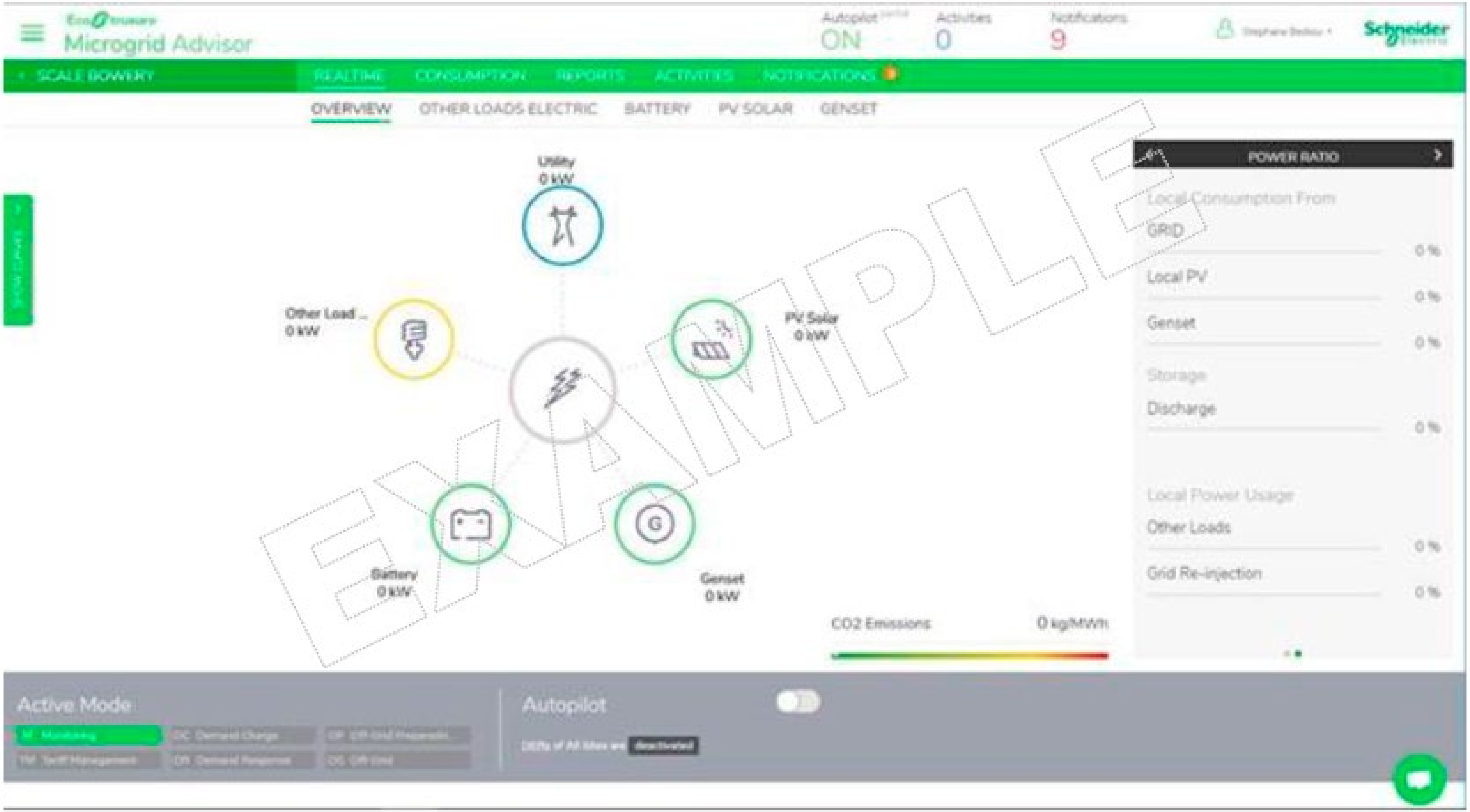

Ongoing Work

- Battery Commissioning
- Submetering Configuration
- Energy Dashboard
- Ongoing Commissioning
- Measurement & Verification

HGA

Thank You

Mike Barnett PE, CCP

Project Manager

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