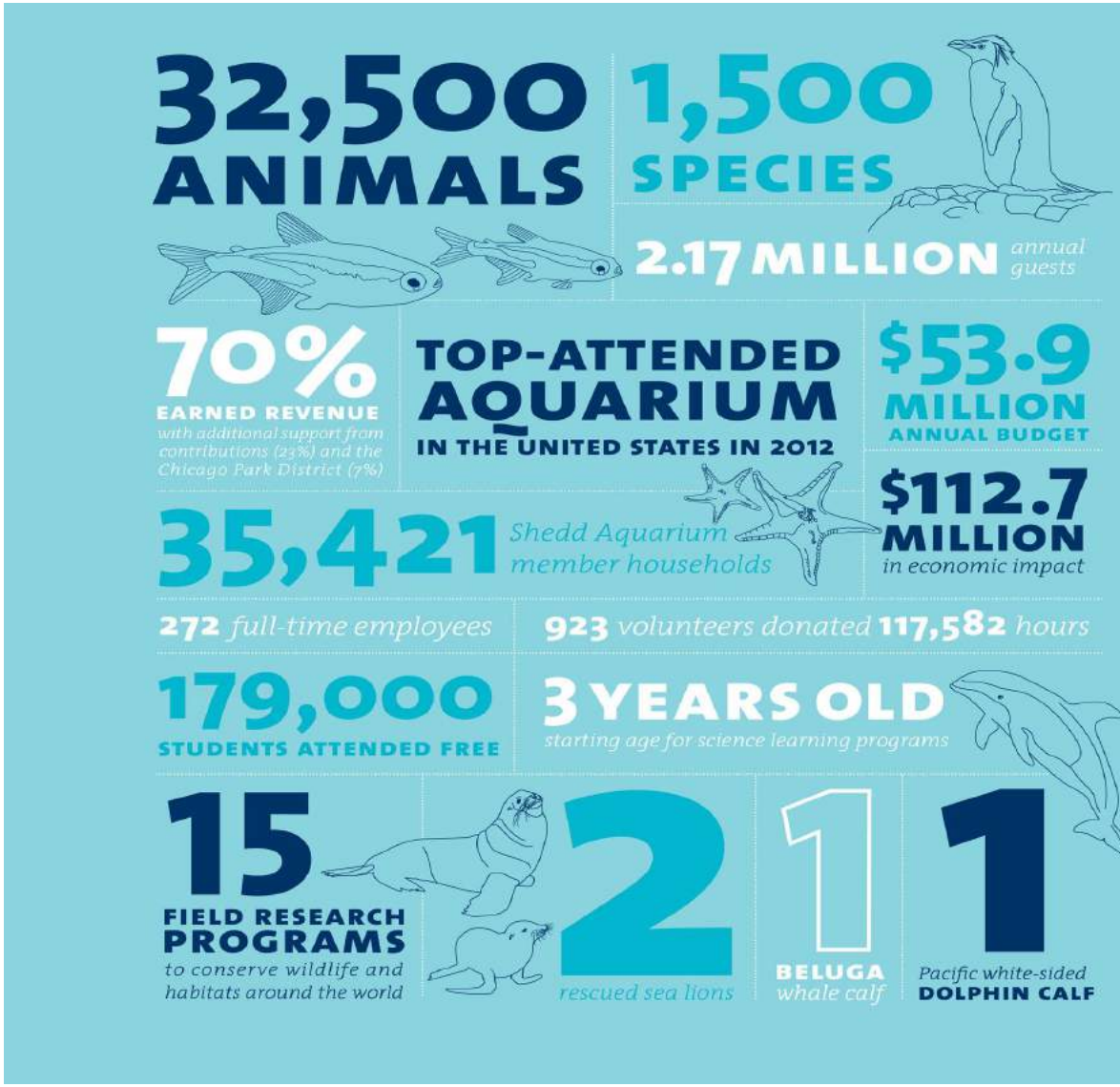
Shedd
AQUARIUM

Sustainability at Shedd

Energy

Shedd Aquarium



Conservation at Shedd

Sustainability at Shedd

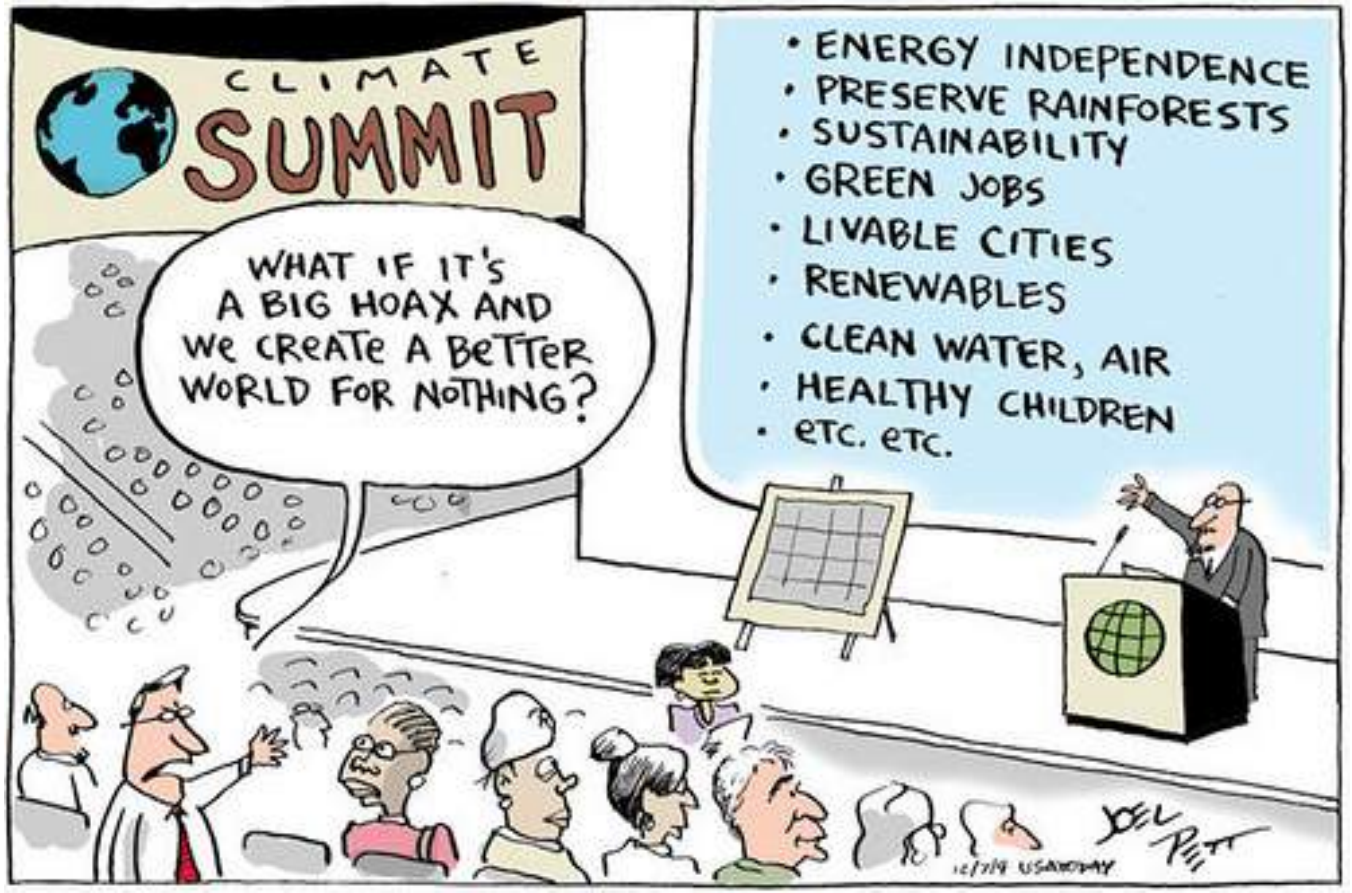
- Energy
- Water
- Waste
- Purchasing
- Chemical Management
- Construction Materials
- Animal Diet
- Coral Reef II (Boat)
- Hospital
- Gardens
- Public Awareness

Why is sustainability important to Shedd?

- Good for business
- Mission
- Accreditation
- Spurs innovation
- Mitigates Risk (Energy)

What is the biggest risk to your business today????

Climate Change



Climate Change

Climate Change

Climate Change

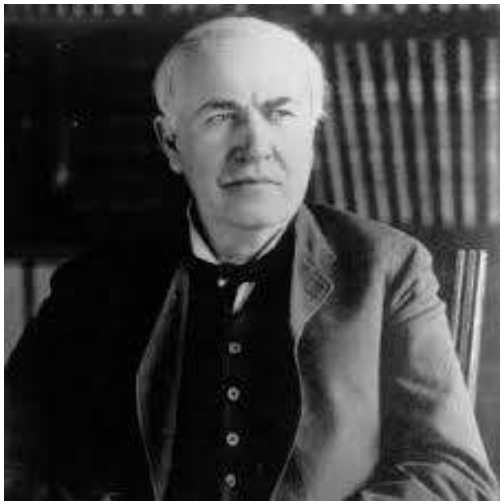
Who Is the person responsible for sustainability in your organization?????

Energy

Stretch Goal:

Shedd Reduces its energy consumption by 50% by 2020.

Energy



“We are like tenant farmers chopping down the fence around our house for fuel when we should be using Nature’s inexhaustible sources of energy--sun, wind and tide. I’d put my money on the sun and solar energy. What a source of power! I hope we don’t have to wait until oil and coal run out before we tackle that.”

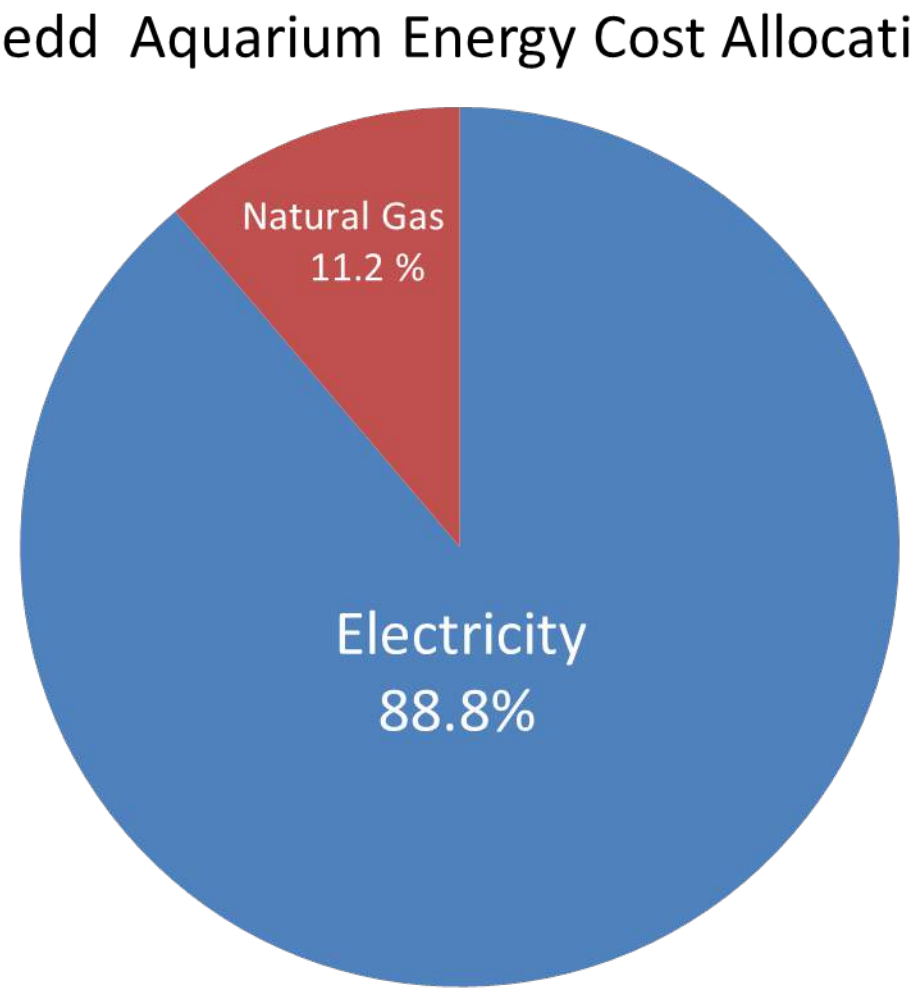
— Thomas A. Edison 1931

Energy Sustainability Plan

Develop a long-term energy strategic plan in 2012 & Operationalize the Plan in 2013.

- Renewables
- Smart Grid (Demand & Frequency Regulation Programs)
- Reduction methods

Energy Audit



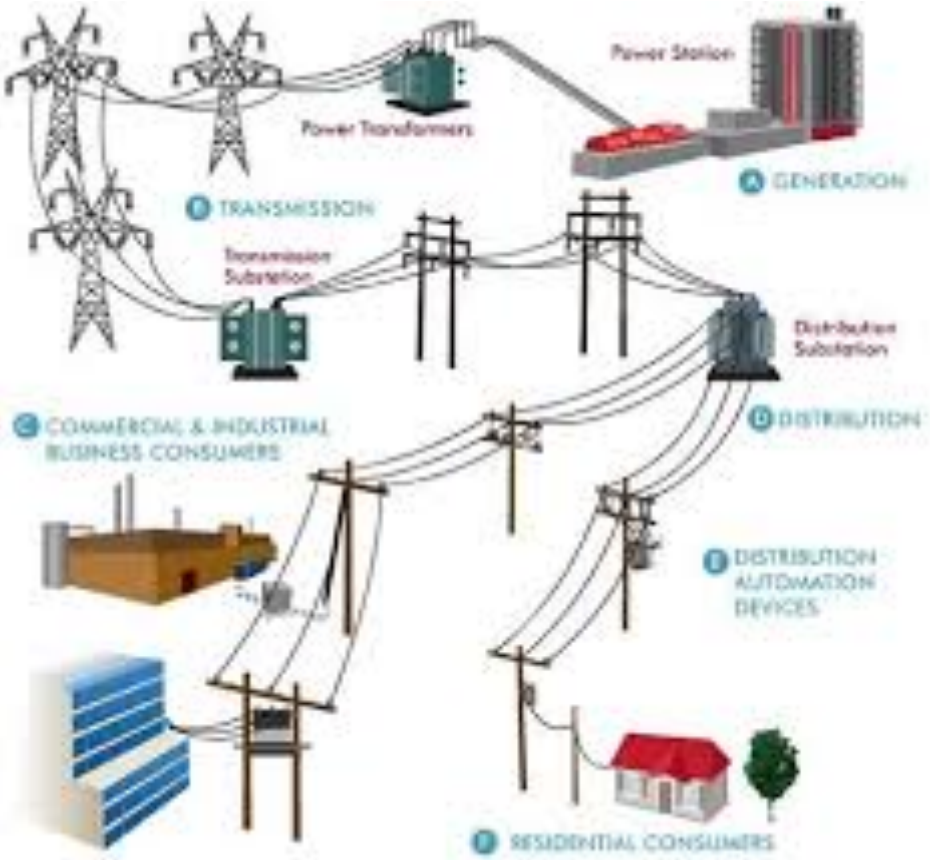
2011 ARUP Benchmark Study Results
National Aquarium

Building	Floor area	Year	Annual Source Energy Consumption	EUI	Performance vs Benchmark
	sf		kbtu		
Comparison Aquarium 1	346,225	2008	364,078,726	1,052	
	346,225	2009	366,573,096	1,059	
	346,225	2010	341,287,001	986	9.7%
Comparison Aquarium 2	356,987	2009	256,965,600	720	
Shedd Aquarium	356,987	2010	271,226,796	760	-15.4%
Comparison Aquarium 3	190,000	2009	149,578,473	787	
	190,000	2010	154,122,509	811	-9.7%
Comparison Aquarium 4	112,318	2008	113,576,426	1,011	
	112,318	2009	113,796,880	1,013	
	112,318	2010	114,055,704	1,015	13.0%
Comparison Aquarium 5	686,000	2010	593,430,403	865	-3.7%
Comparison Aquarium 6	138,000	2009	122,563,006	888	
	138,000	2010	121,864,415	883	-1.7%

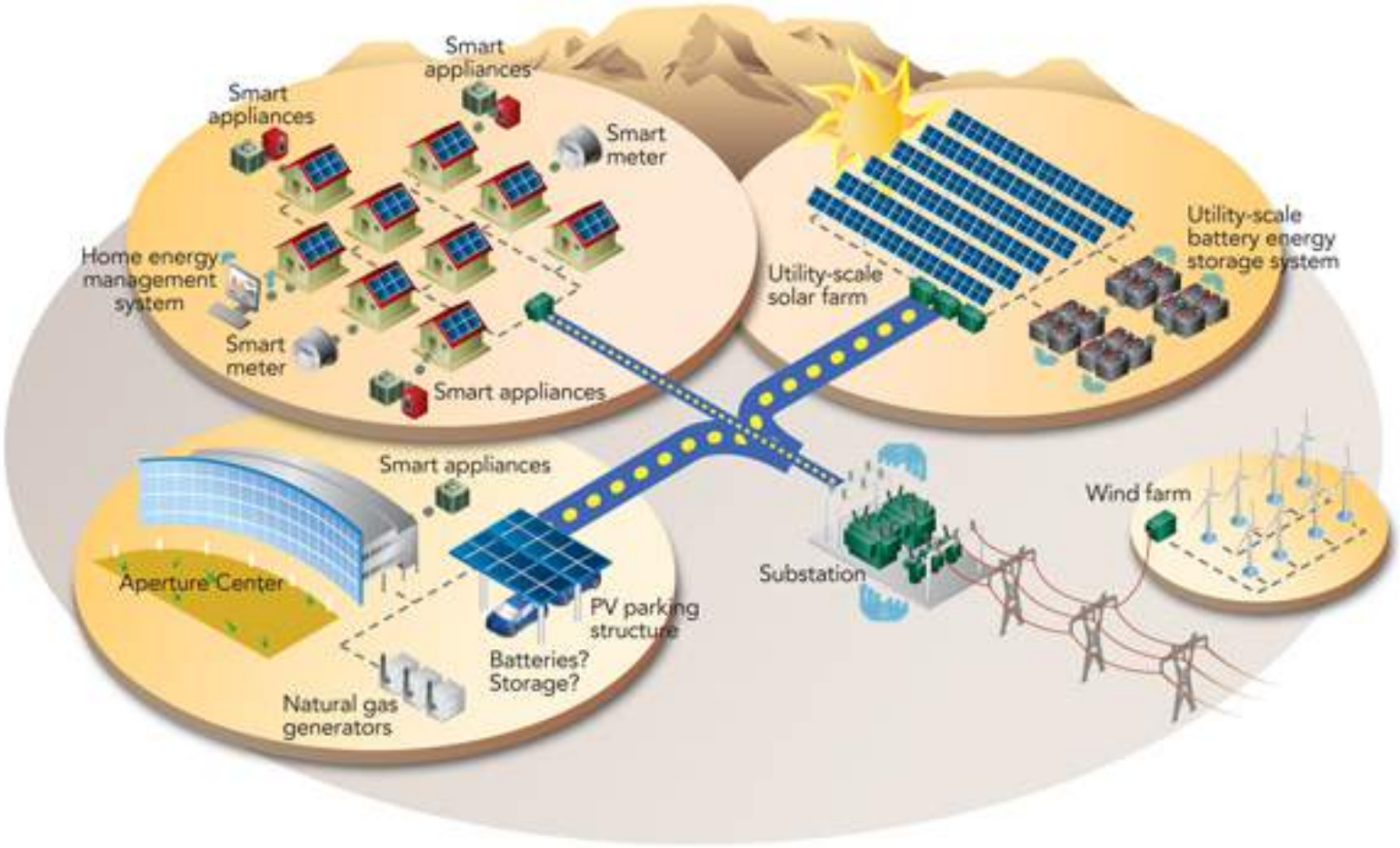
469

Benchmark Energy Use Intensity	898	kbtu/sf/yr

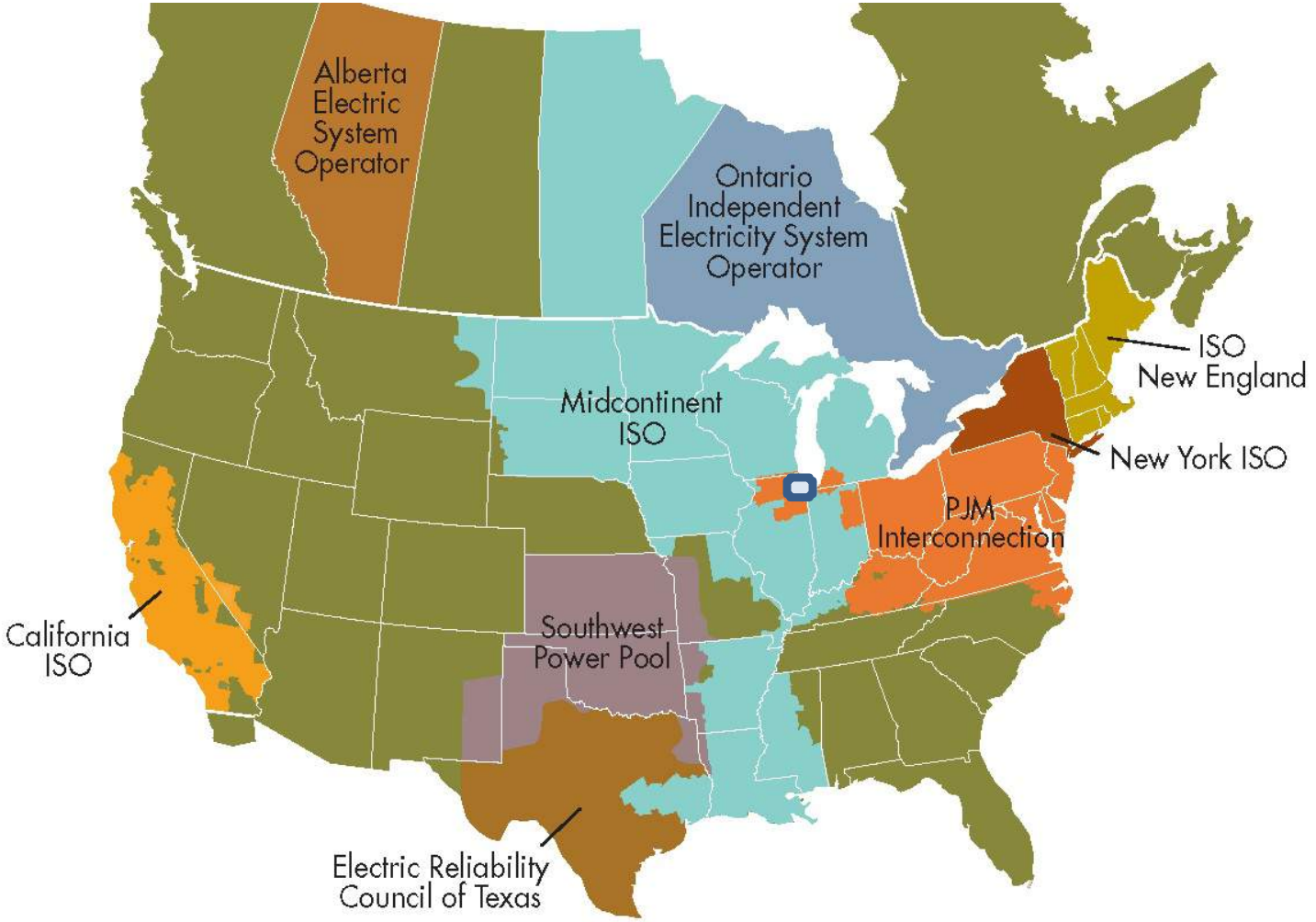
Old Grid


Power Transformers
Power Station
A GENERATION
B TRANSMISSION
Transmission Substation
Distribution Substation
C COMMERCIAL & INDUSTRIAL BUSINESS CONSUMERS
D DISTRIBUTION
E DISTRIBUTION AUTOMATION DEVICES
F RESIDENTIAL CONSUMERS

The Modern Electricity Grid (Smart Grid)



North American Grid ISO



Master Energy Roadmap

Current State: "Energy Saver"

A forward thinking institution working to reduce energy *consumption*. A energy saver implements discrete modifications to improve sustainable energy use but **lacks an integrated energy management strategy.**

Level 1 (2015) "Energy Leader"

A leading institution focusing efforts on **reducing energy consumption**. An energy leader implements industry leading practices for **energy tracking,usage,and sourcing**,while engaging the public in their efforts.

Level 2 (2020) "Energy Innovator"

First Smart Energy Aquarium

A state-of- the –art institution which facilities from around the globe look to for sustainable energy practices. An Energy innovator implements **integrated energy management strategies** and showcases **advanced technologies**.

Master Energy Roadmap

Current State: "Energy Saver"

- High Efficiency chillers.
- Free Cooling Heat Exchangers
- Building Automation system.
- LED lighting
- Data collection
- Committed to operational efficiencies

Level 1 (2015) "Energy Leader"

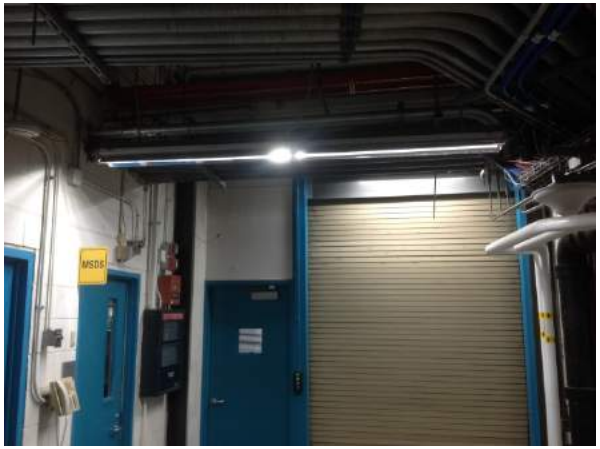
- Install sub meters for real time data collection
- Optimize pump efficiencies with VFD drive
- Power quality (Power factor)
- Continue LED retro-fits
- On-Site Solar.

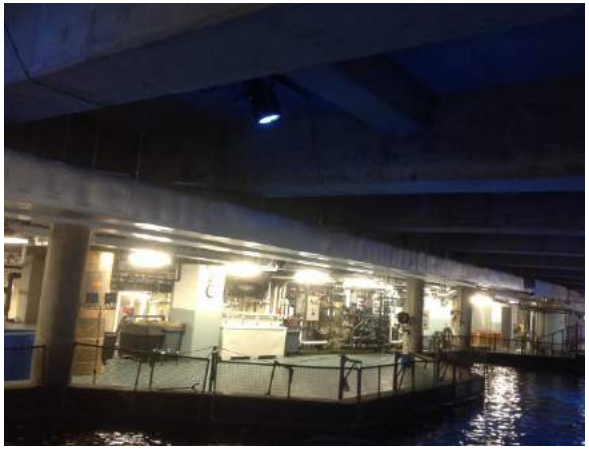
Level 2 (2020) "Energy Innovator"

First Smart Energy Aquarium

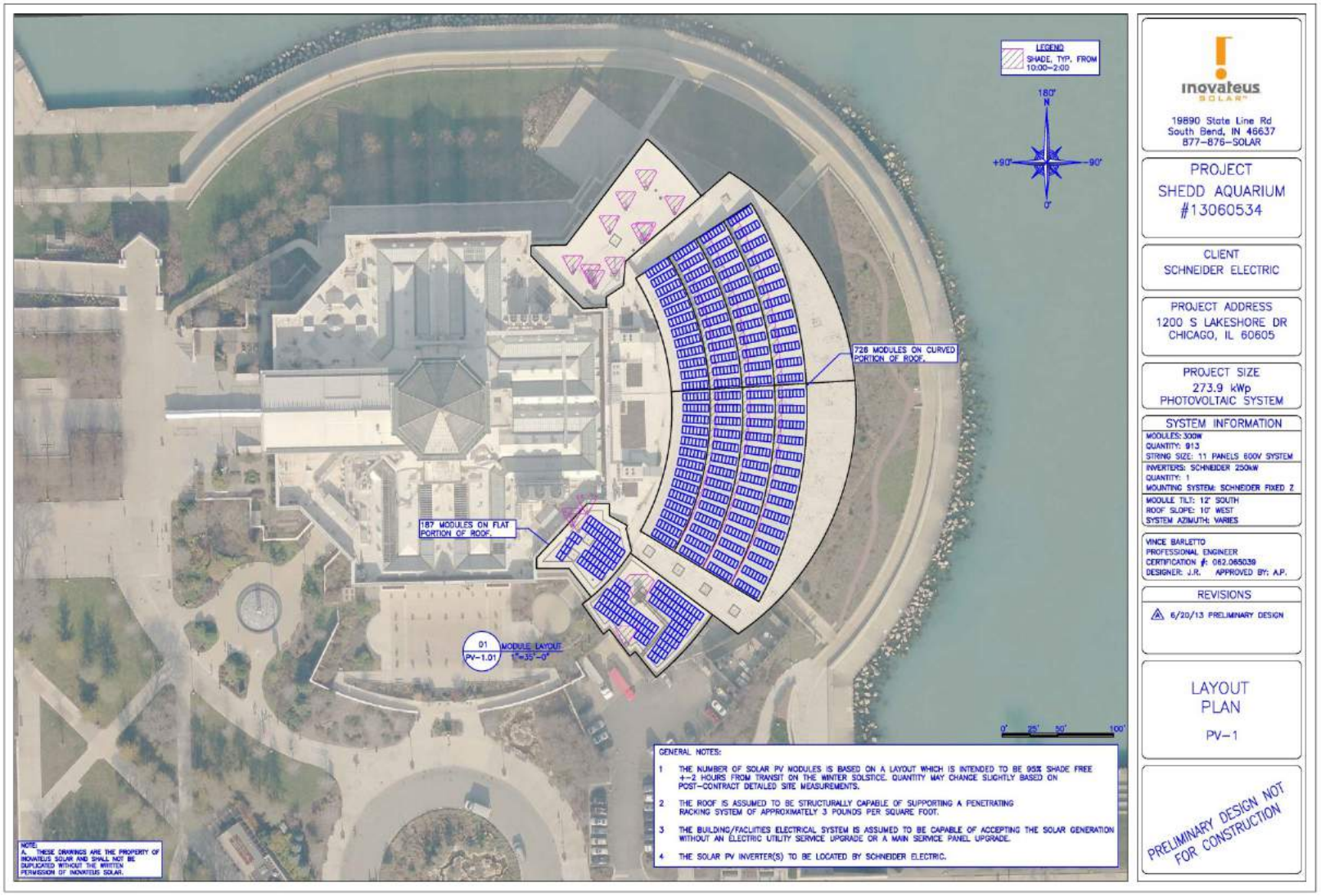
- Advanced Lighting Control
- Building Analytic Software
- Advanced Daylight Harvesting
- Campus Solar 1.5 MW
- Real Time Energy Pricing
- Advanced Demand response
- Frequency Regulation Markets

LED Lighting





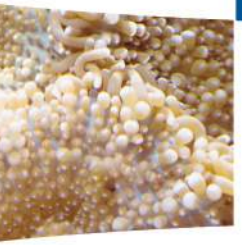
Solar 265 KW


LEGEND
SHADE, TYP. FROM 10:00–2:00
180°
N
+90°
-90°
0°
726 MODULES ON CURVED PORTION OF ROOF.
187 MODULES ON FLAT PORTION OF ROOF.
01
PV-1.01
MODULE LAYOUT
1"=35'-0"
0'
25'
50'
100'
GENERAL NOTES:
1 THE NUMBER OF SOLAR PV MODULES IS BASED ON A LAYOUT WHICH IS INTENDED TO BE 95% SHADE FREE +-2 HOURS FROM TRANSIT ON THE WINTER SOLSTICE. QUANTITY MAY CHANGE SLIGHTLY BASED ON POST-CONTRACT DETAILED SITE MEASUREMENTS.
2 THE ROOF IS ASSUMED TO BE STRUCTURALLY CAPABLE OF SUPPORTING A PENETRATING RACKING SYSTEM OF APPROXIMATELY 3 POUNDS PER SQUARE FOOT.
3 THE BUILDING/FACILITIES ELECTRICAL SYSTEM IS ASSUMED TO BE CAPABLE OF ACCEPTING THE SOLAR GENERATION WITHOUT AN ELECTRIC UTILITY SERVICE UPGRADE OR A MAIN SERVICE PANEL UPGRADE.
4 THE SOLAR PV INVERTER(S) TO BE LOCATED BY SCHNEIDER ELECTRIC.
NOTE:
A. THESE DRAWINGS ARE THE PROPERTY OF INOVATEUS SOLAR AND SHALL NOT BE DUPLICATED WITHOUT THE WRITTEN PERMISSION OF INOVATEUS SOLAR.
inovateus SOLAR
19890 State Line Rd
South Bend, IN 46637
877-876-SOLAR
PROJECT
SHEDD AQUARIUM
#13060534
CLIENT
SCHNEIDER ELECTRIC
PROJECT ADDRESS
1200 S LAKESHORE DR
CHICAGO, IL 60605
PROJECT SIZE
273.9 kWp
PHOTOVOLTAIC SYSTEM
SYSTEM INFORMATION
MODULES: 300W
QUANTITY: 913
STRING SIZE: 11 PANELS 600V SYSTEM
INVERTERS: SCHNEIDER 250kW
QUANTITY: 1
MOUNTING SYSTEM: SCHNEIDER FIXED Z
MODULE TILT: 12° SOUTH
ROOF SLOPE: 10° WEST
SYSTEM AZIMUTH: VARIES
VINCE BARLETTO
PROFESSIONAL ENGINEER
CERTIFICATION #: 062.065039
DESIGNER: J.R. APPROVED BY: A.P.
REVISIONS
A 6/20/13 PRELIMINARY DESIGN
LAYOUT PLAN
PV-1
PRELIMINARY DESIGN NOT FOR CONSTRUCTION

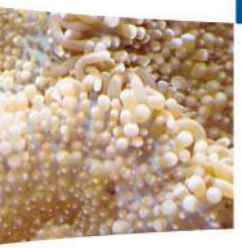
Solar 265 KW

Oceanarium VFD Installation (Tools)

1-Mega-Watt Battery



1-Mega-Watt Battery



PJM
(Grid ISO)

Viridity Energy
CSP

Network Operation Center
- Daily Market Operation & Management
- Remote Battery Monitoring

Shedd Team

- Provide Land
- Provide Data
- Provide electrical load

- EPC of Battery System

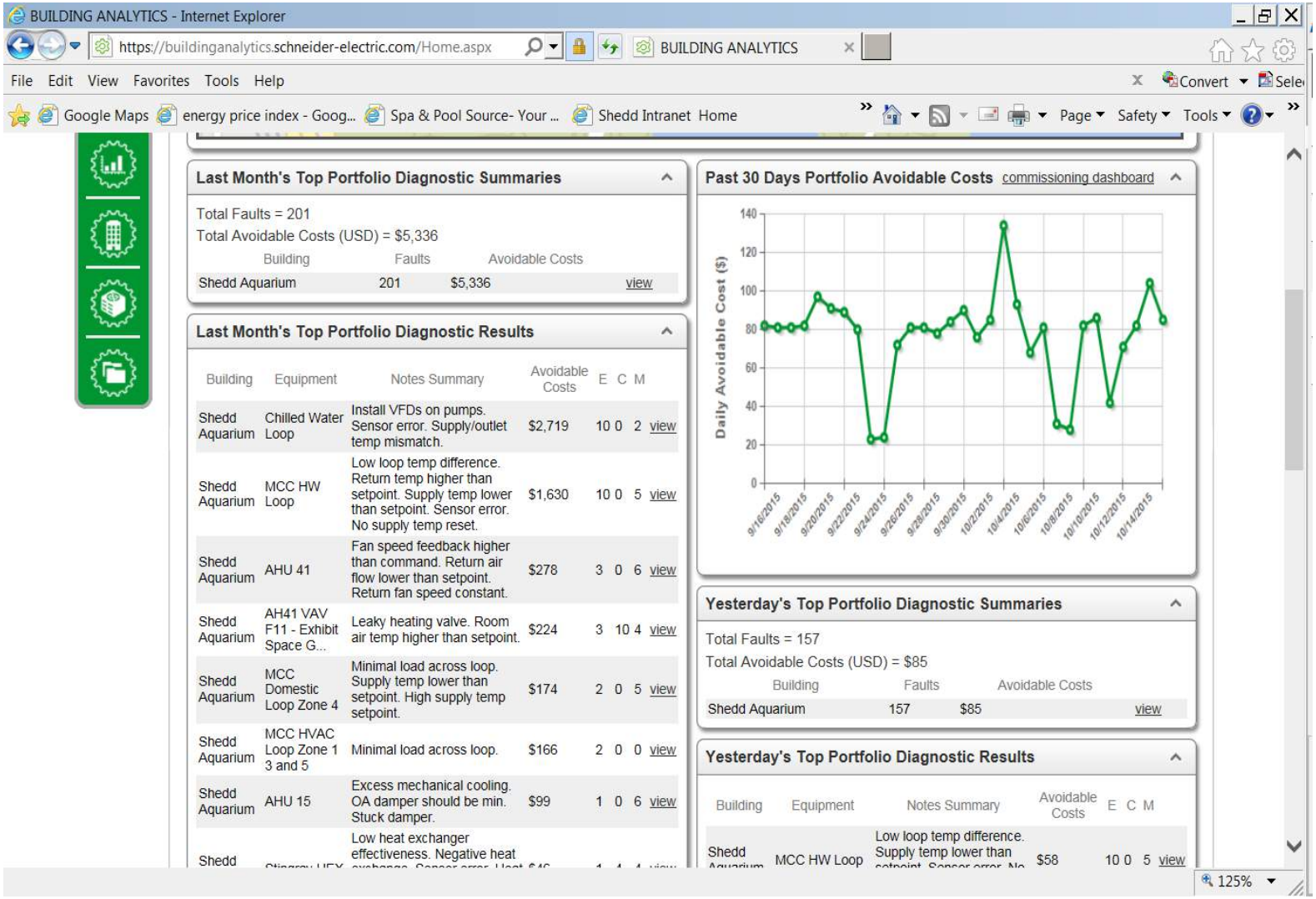
Schneider Electric

Eagle Picher Technologies

- Provide Capital
- Manufacture Battery System
- Technical Advisory Support
- Maintenance

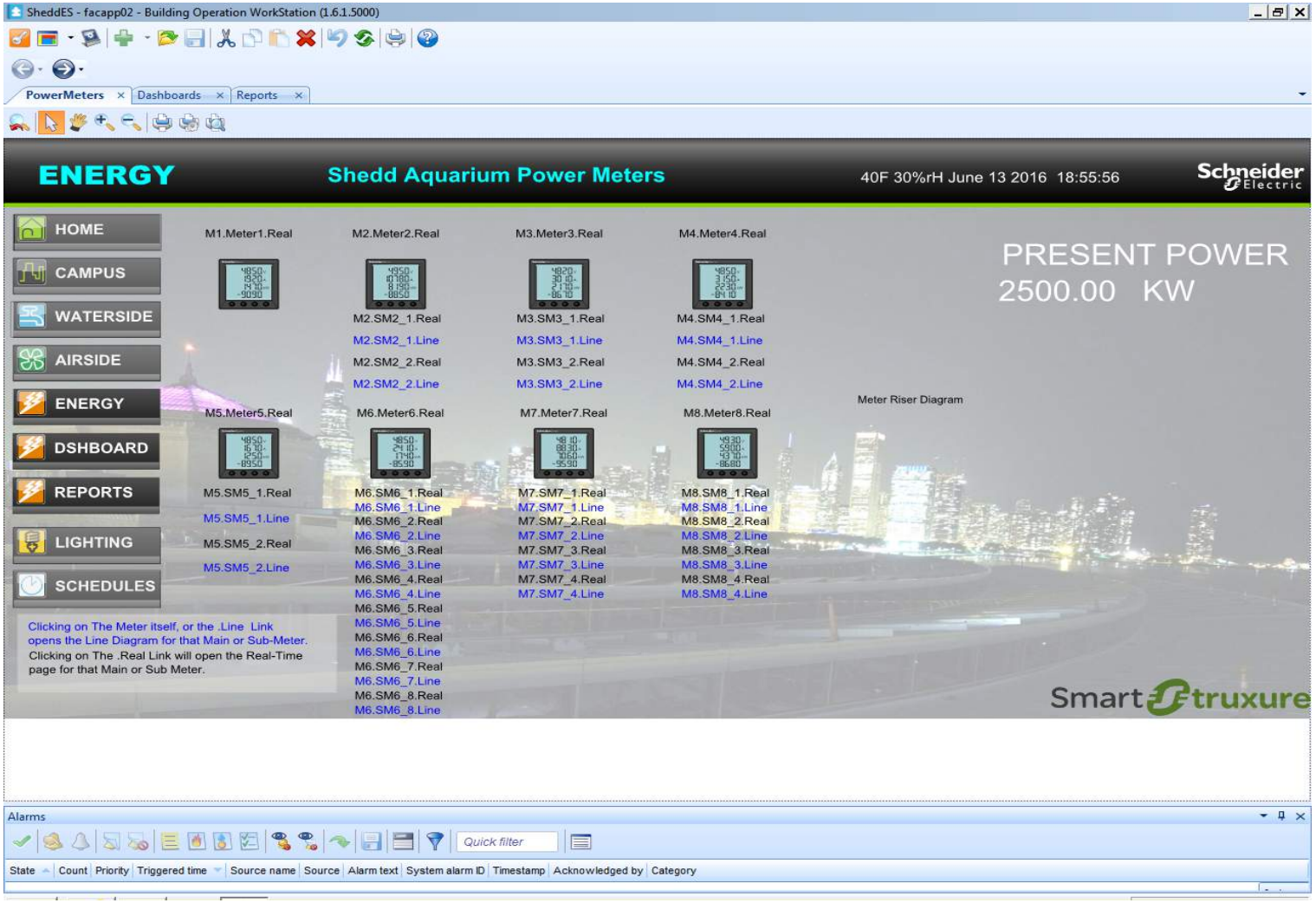
Building Analytics

(Monitor Based Commissioning)

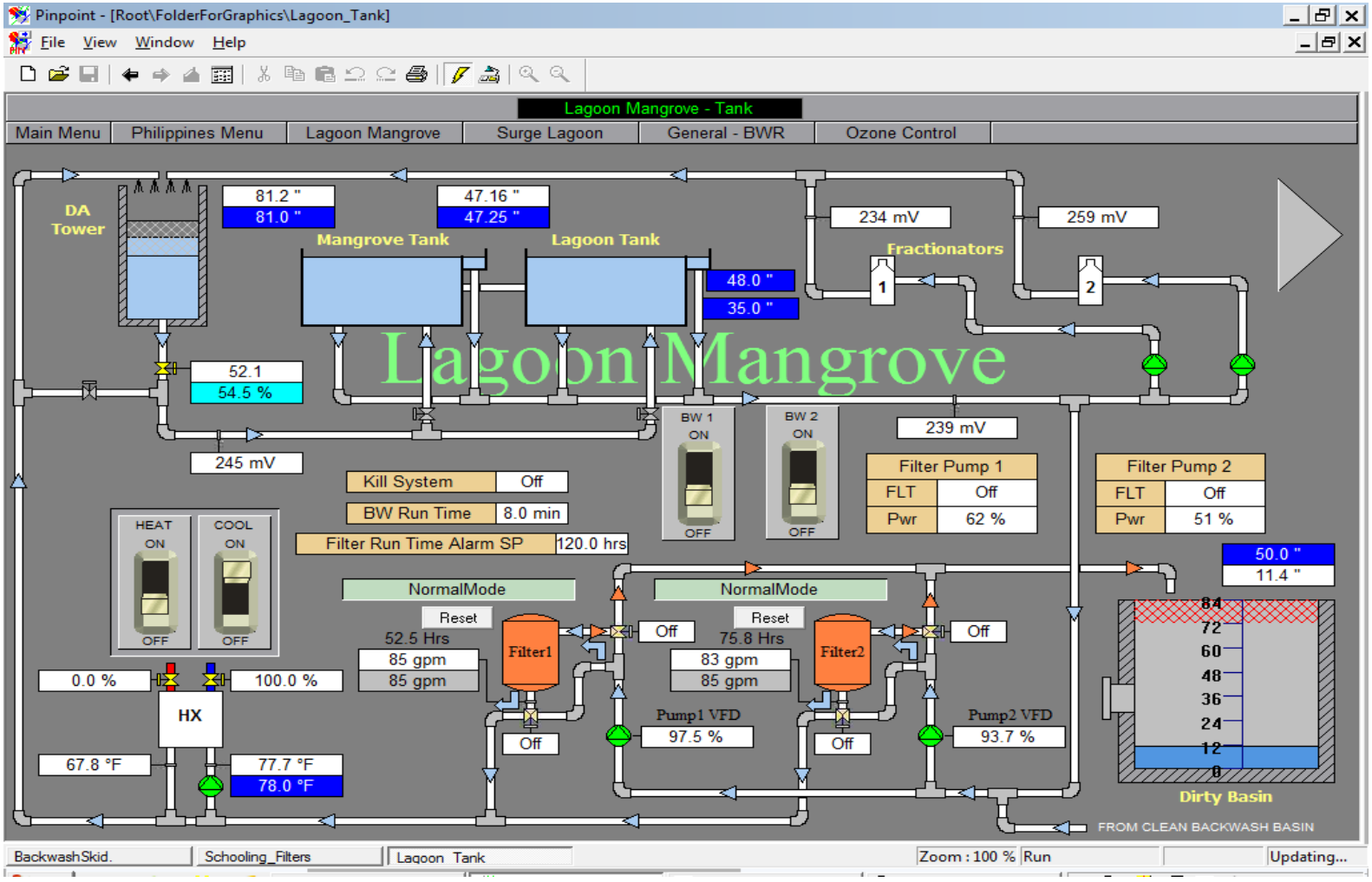


Power Monitoring

Power Monitoring

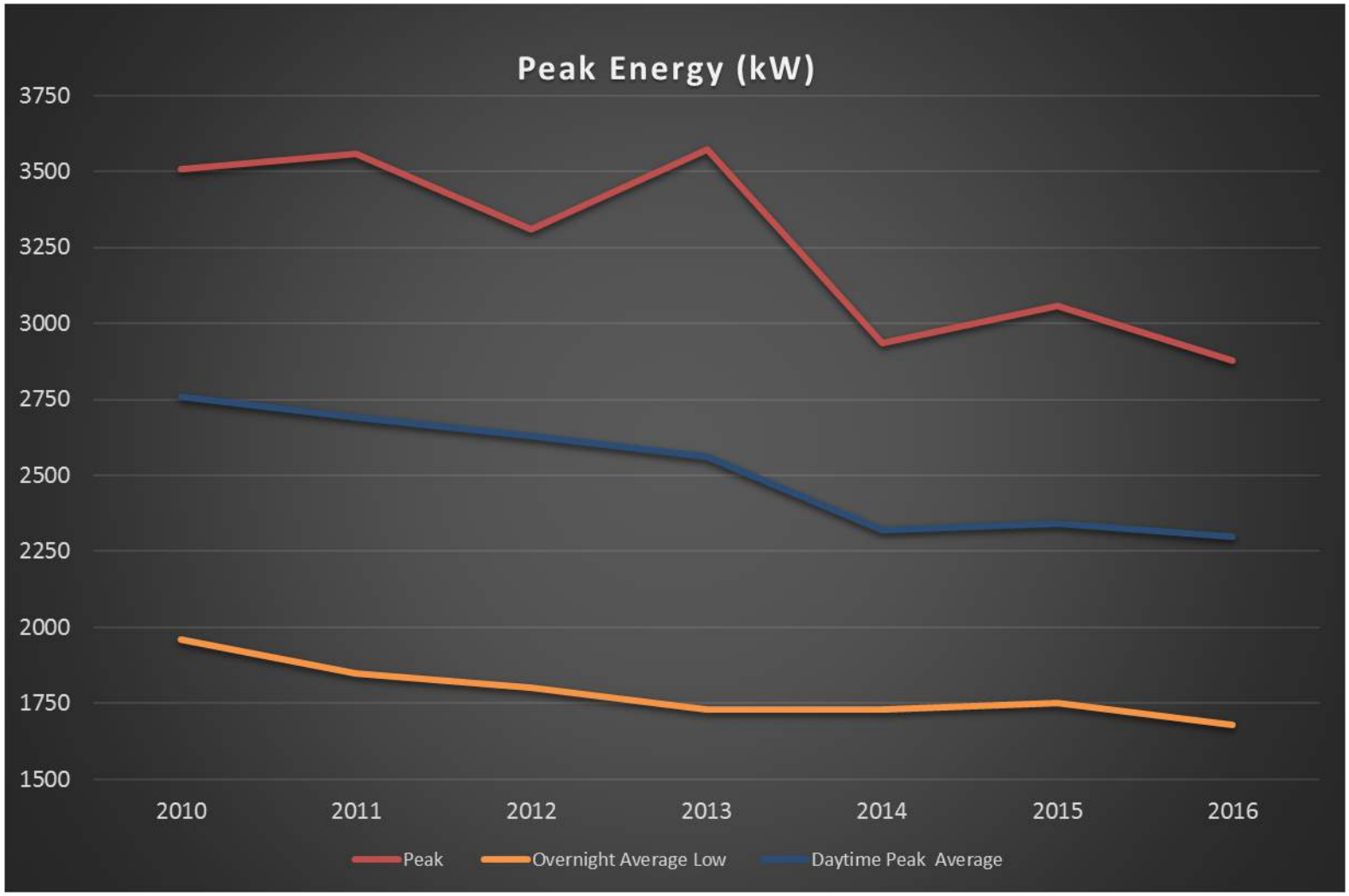


The Test??? 18,000 gallon Fish System

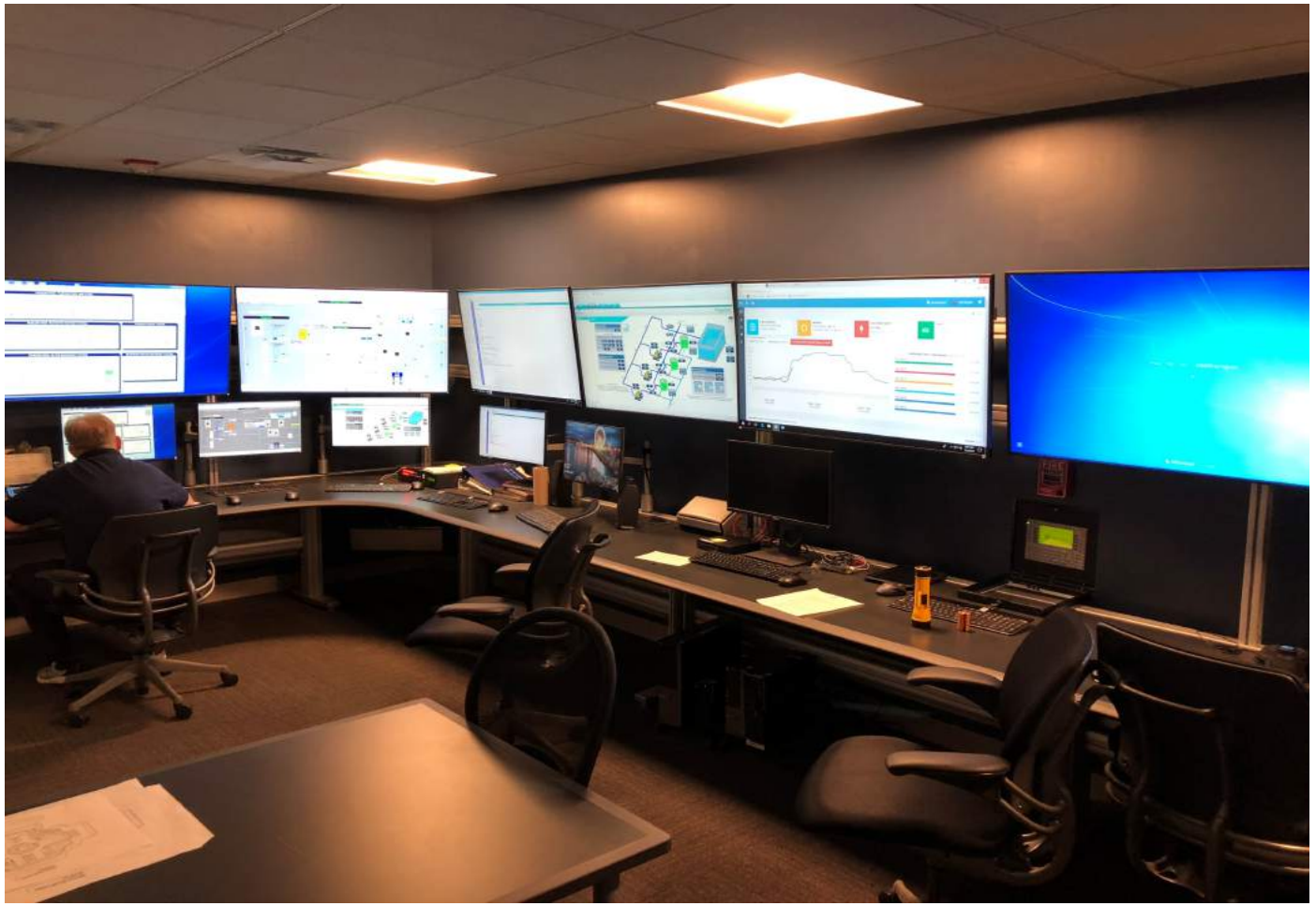


Bring Loads Under Control LSS and Mechanical

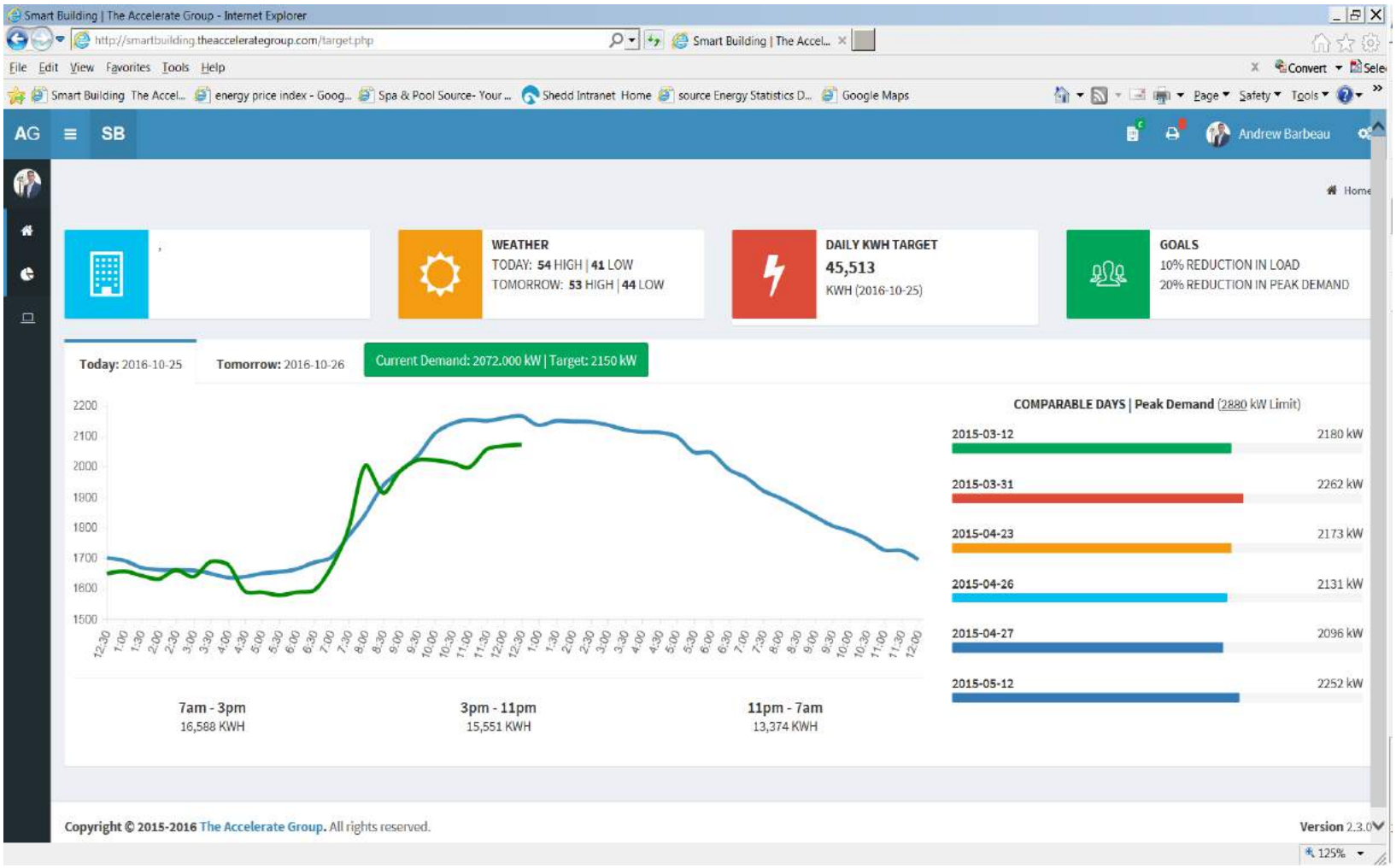
Peak Energy (2010-2016)



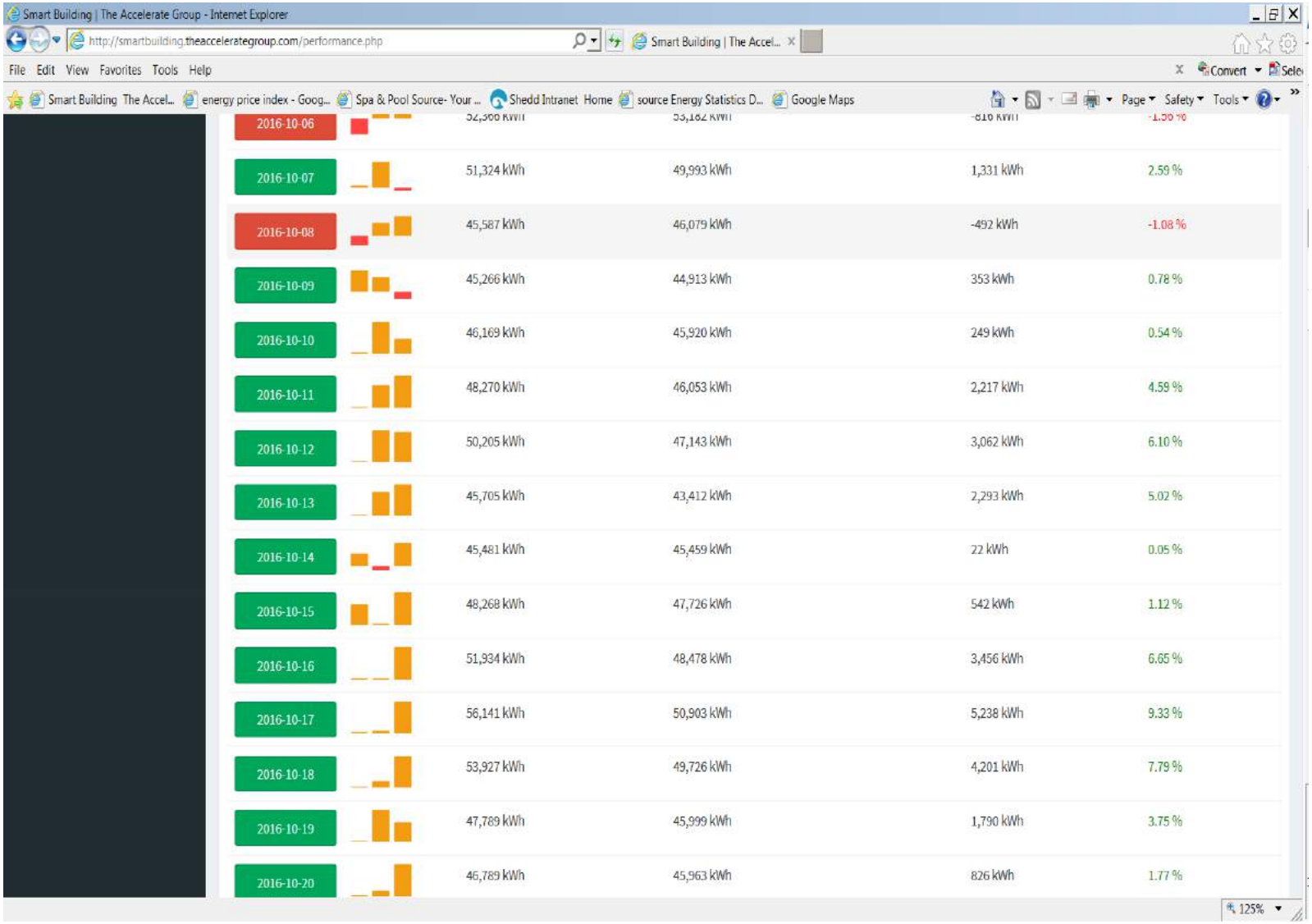
Smart Operator Training



Smart Operator Training



Smart Operator Training



2016-10-06	52,366 kWh	53,182 kWh	-816 kWh	-1.56 %
2016-10-07	51,324 kWh	49,993 kWh	1,331 kWh	2.59 %
2016-10-08	45,587 kWh	46,079 kWh	-492 kWh	-1.08 %
2016-10-09	45,266 kWh	44,913 kWh	353 kWh	0.78 %
2016-10-10	46,169 kWh	45,920 kWh	249 kWh	0.54 %
2016-10-11	48,270 kWh	46,053 kWh	2,217 kWh	4.59 %
2016-10-12	50,205 kWh	47,143 kWh	3,062 kWh	6.10 %
2016-10-13	45,705 kWh	43,412 kWh	2,293 kWh	5.02 %
2016-10-14	45,481 kWh	45,459 kWh	22 kWh	0.05 %
2016-10-15	48,268 kWh	47,726 kWh	542 kWh	1.12 %
2016-10-16	51,934 kWh	48,478 kWh	3,456 kWh	6.65 %
2016-10-17	56,141 kWh	50,903 kWh	5,238 kWh	9.33 %
2016-10-18	53,927 kWh	49,726 kWh	4,201 kWh	7.79 %
2016-10-19	47,789 kWh	45,999 kWh	1,790 kWh	3.75 %
2016-10-20	46,789 kWh	45,963 kWh	826 kWh	1.77 %

Load Management Plan

SHEDD AQUARIUM LOAD MANAGEMENT PLAN

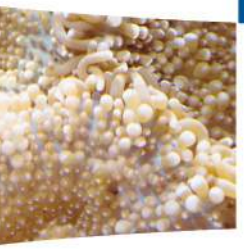
	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM
MAIN SPACE CHILLER	OCEANARIUM 68 AQUARIUM 72			MAINTAIN AND RIDE - OCEANARIUM 68 AQUARIUM no higher than 74			GET OCEANARIUM TO 68 BY 6 GET AQUARIUM TO 72 BY 6 GET BUBBLENET TO 72 BY 6				OCEANARIUM - Coast up but lower than 71 AQUARIUM To 68 BUBBLENET To 68		
CHILLER - WATER	CW Supply Setpoint 39-41 As Needed												
VFDs						2 LG. AND 1 SMALL OFF – Lowest flowing filters REST OF LG. TO 600 GPM REST OF SMALL TO 800 GPM OTTER DOWN TO 200 GPM 1 PENGUIN OFF						
PUMPS	NO OCEANARIUM BACKWASHING						NO BACKWASHING ALL OTHER SHUT-OFF: RAIN WATER PUMP – switch to city water SHARK,SCHL, CR Hex off Q12, Q15, Q16 Shut Off HX – Check with Quar S.E. QUAD Recirc Pumps, Check with fishes – Shut off Basins 1,2,3,4						
LIGHTING								EDUCATION / CONSERVATION LIGHTING OFF					
HVAC							ADJUST FAN SPEED/ COOLING VALVE POSITION BY RAISING TEMP SET POINTS + OR – 1 DEGREE BASED ON SPACE RETURN TEMP						
BUILDING ENVELOPE							Security - MAN DOORS						
OTHER EQUIP.						SHUT OFF R.O., 3- SUB BASEMENT DEHUM.							

= ENERGY SAVING

= ENERGY USING

DO NOT EXCEED	2,850 KW	BETWEEN 6AM-6PM

Building Operator Guidelines



Building Operations guidelines 80° and above

- General Goal: Do not run the two chillers over 80% from 7:00 am to 9:00 pm.

11:00 to 7:00 3rd Shift

- Make sure Shark, Schooling and Reef are set to 77.5° and cooling. We should never start a day when the outside temperature is 80° and above with these systems above the set-point of 78°.
- Make sure the Oceanarium pools are cooling. Cool down to set point.
- Make sure all lighting is off.
- Make sure dome lights are off.
- Make sure air handlers are off except those that are scheduled to run 24 hours.
- Make sure roof lights are off at 1:00 am
- Walk through the offices to check for computers and lights that are left on. Walk through galleries as well. Take an inventory of what is left on.

7:00 to 3:00 1st Shift

- All Oceanarium pools off by 7:30 am.
- Shark, Reef and Schooling set to 79°.
- If the chillers start to go above 80% please use the below steps.
  - Raise return air temperatures on the air handlers by 1 degree (Try not to Exceed 74°)
  - Raise the chilled water supply temperature by 1 degree not exceeding 43 degrees.(We would like to keep the chilled water at 39 degrees however to keep the loads down we may need to alter the temperature. Your first step is to manage the air handlers return air temperatures.)
- As we approach 2600 kW, begin to lower Oceanarium flows.
  - Small Pool - normal setpoint is 1100gpm - may go down to 800 gpm
  - Large Pool - normal setpoint is 1000gpm - may go down to 650 gpm
  - Shut off Otter Hex
  - If not too busy, adjust AHU – 1,2 Supply VFD's 5% lower
- First shift operator needs to **document all changes** in the logbook that were made and discuss them with the second shift operator. Pass along what needs to be reset in the logbook.

3:00 to 11:00 2nd Shift

- Verify air handler return air temps with the first shift. Make sure all normal set points are back in place after 8:00 pm.
- If there is no party make sure all the air handlers are off except for the air handlers that are scheduled to run 24 hours.
- Make sure all lighting is off.
- Once the air handlers are off begin cooling the pools. Begin to lower the CW Supply Temperature back to 39 Degrees. (Cooling of pools is most effective at this temperature)
- Make sure that Shark, Schooling, and the Reef tank are set to 77.5° after 8pm or event ending.

Review Air Handler Settings on Backside

Standard Summer Temperature Settings and Times

AHU	Space	On Time	Off Time	RAT SP	DAT SP	Space SP
1	Oceanarium	7:00	18:00	72°		
2	Oceanarium	7:30	18:00	72°		
5	Phelps/ Oceanarium	7:00	18:00	72°		
6/7	Kitchen	5:30	18:00	71°		
8	Soundings/ Bubblenet	8:00	18:00	72°		
9	Underwater viewing/North Lobby	7:00	18:00	72°		
10	Gift Shop/Volunteer?Mammal/Dog	5:00	22:00	72°		
11	Mammal Reheat (Lockers/Otters)	24/7			64°	
13	Underwater/PPZ/Penguin	24/7		71°		
RTU-1	Office Suite	6:30	18:00	72°		
RTU-2	Office Suite	6:30	18:00	72°		
RTU-3	Special Exhibits	24/7		70°		
15	Lab/ Accessible	7:00	20:00		50°	
16	Galleries 4,5,6	8:30	18:00		50°	
17	Gift Store	7:00	20:45		60°	72°
18	Main Foyer	8:30	18:00	72°	52°	
19	Reef Rotunda	7:30	18:00	72°	48°	
20	Education	8:00	20:00		54°	
40	Amazon -Public	6:00	23:59		63	78.0°
41	Amazon - Animals	24/7				78.0°
42	Philippines - Public	6:00	18:00		57.5°	
43	Philippines - Service Deck	6:00	17:00		63.0°	68.0°
44	Quarantine	24/7			55.0°	72.0°
45	Dry Holding	24/7		72°		

Pump Setting Log

Mar 23, 2017.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Developer Acrobat

U14

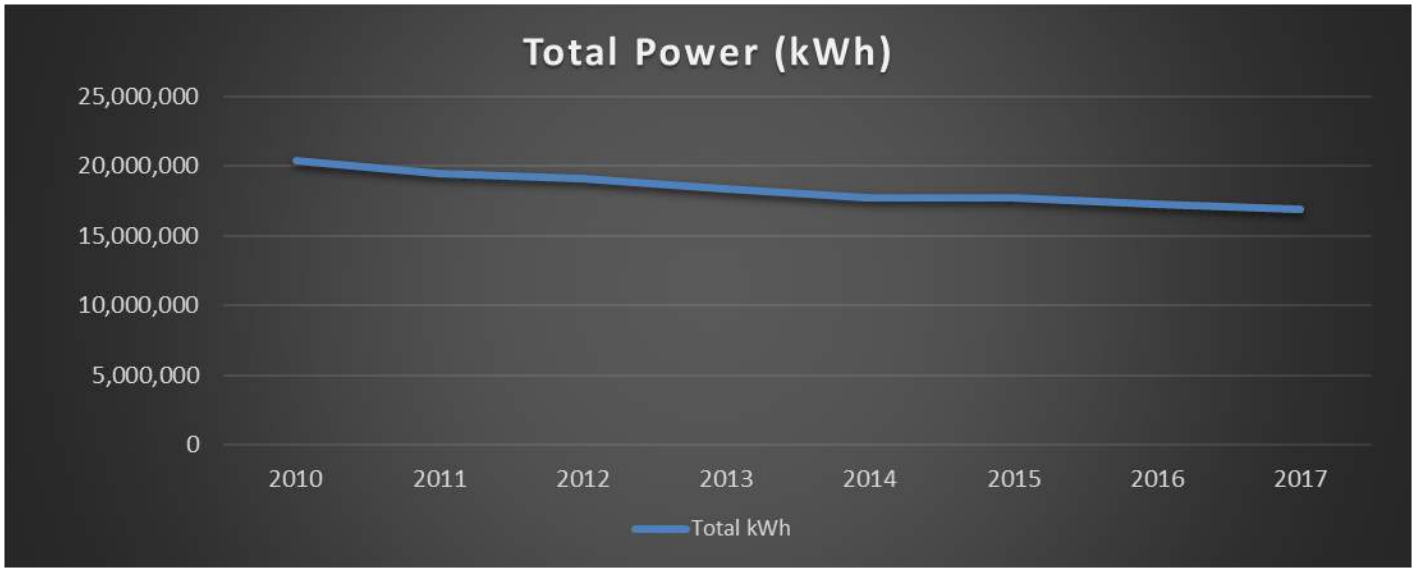
Energy Log

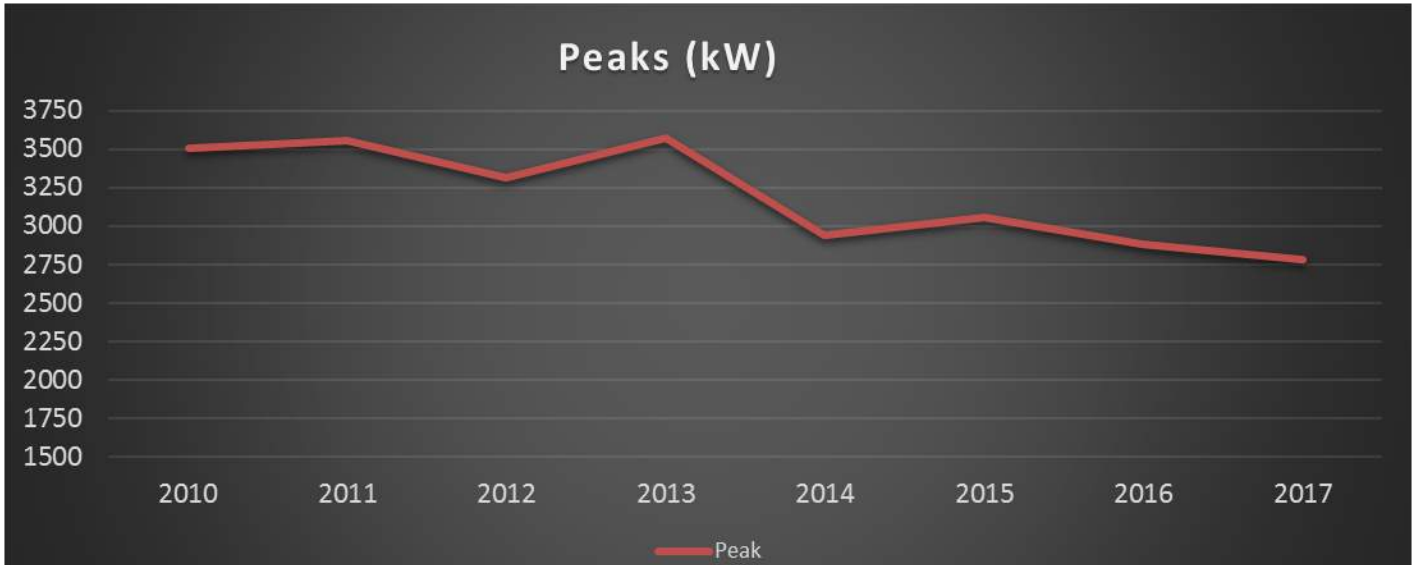
Date:	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00
ChW Supply SP	39	39	39	39	39	39	39	39	39	39	39	39	39	39
Large	Normal Flow-1000gpm-- May Reduce to 600gpm--upto 4 pumps off at same time													
1	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
2	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
3	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
4	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
5	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
6	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
7	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
8	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Small	Normal Flow-1100gpm-- May Reduce to 600gpm--upto 2 pumps off at same time													
1	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
2	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
3	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
4	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
Holding	Normal Flow-230gpm-- May Reduce to 200gpm--upto 1 pump off at same time													
1	230	230	230	230	230	230	230	230	230	230	230	230	230	230
2	230	230	230	230	230	230	230	230	230	230	230	230	230	230
3	230	230	230	230	230	230	230	230	230	230	230	230	230	230
4	230	230	230	230	230	230	230	230	230	230	230	230	230	230
Penguin	Normal Flow-400gpm-- May Reduce to 275gpm-													
1	400	400	400	400	400	400	400	400	400	400	400	400	400	400
2	400	400	400	400	400	400	400	400	400	400	400	400	400	400
3	400	400	400	400	400	400	400	400	400	400	400	400	400	400
Otter	Normal Flow-230gpm-- May Reduce to 200gpm--upto 1 pump off at same time													
1	230	230	230	230	230	230	230	230	230	230	230	230	230	230
2	230	230	230	230	230	230	230	230	230	230	230	230	230	230
3	230	230	230	230	230	230	230	230	230	230	230	230	230	230

Sheet1 Sheet2 Sheet3

100%

Total Energy (2010-2017)





Campus Micro Grid

Microgrid

A **microgrid** is a small-scale power grid that can operate independently or in conjunction with the area's main electrical grid.

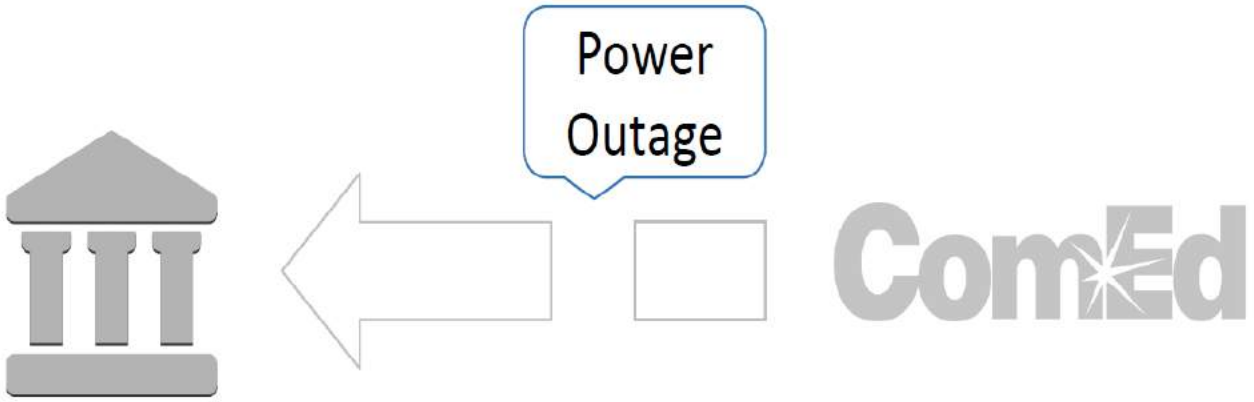
Campus Micro-Grid

How a Microgrid Works

On a typical day, the electric utility provides electricity to the campus

Campus Micro-Grid

How a Microgrid Works



During a power outage event, the utility can no longer provide this service

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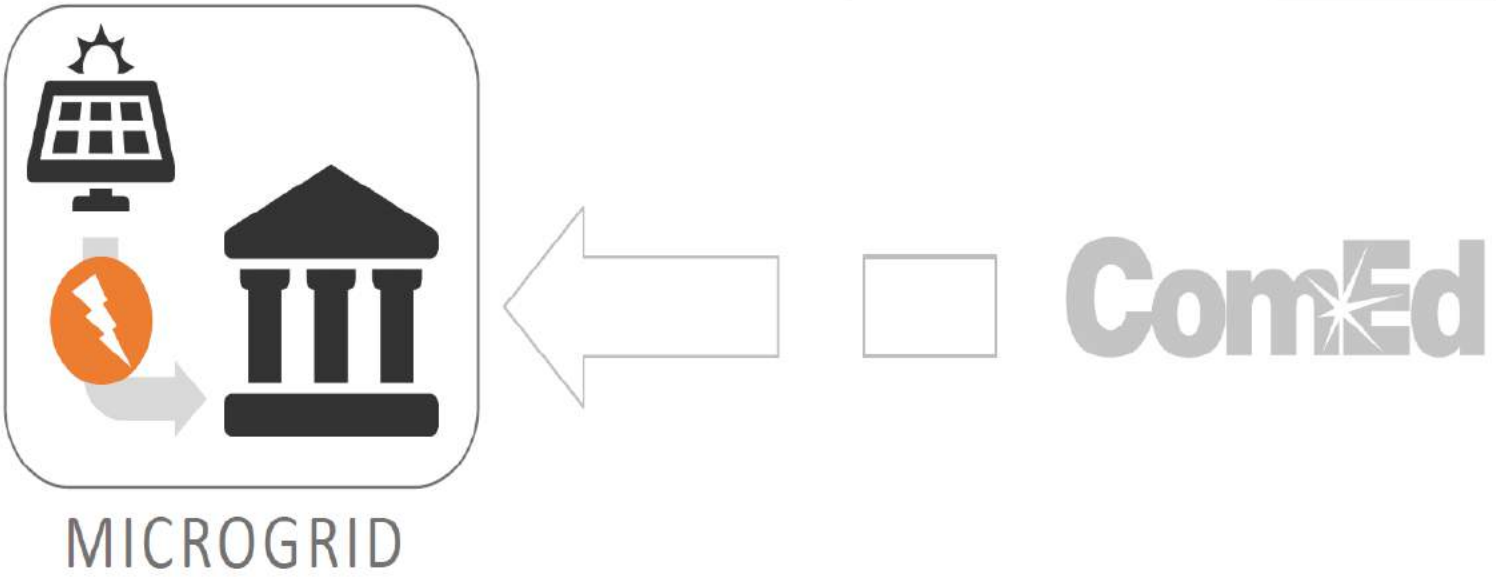

A microgrid can provide the power needed to remain open for business

My Real Motivation