UMass Amherst

MARCH 7, 2019



BENEFITS OF AN ENERGY COMMAND CENTER

ZAC BLOOM — *VP, Head of Renewables*, Competitive Energy Services
STEVE GRDEN — *Utility Electrical Engineer*, UMass Amherst

Competitive Energy SERVICES

SHARING SOLUTIONS, SUSTAINING OUR FUTURE
CampusEnergy2018

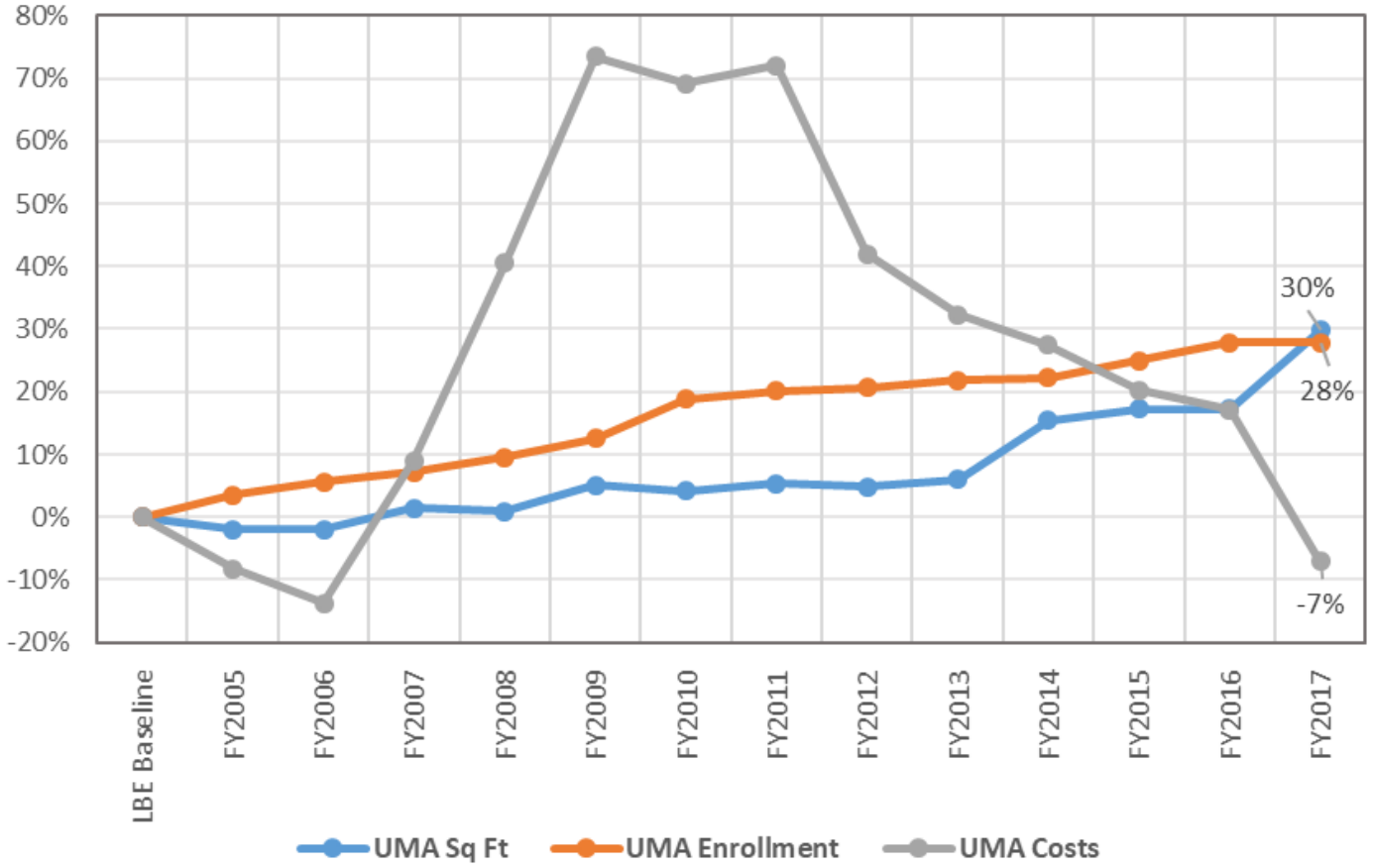
AGENDA

1. UMass Amherst Campus
   - **Background & Context**
2. Anatomy of costs
   - **Eversource T-5 Tariff**
   - **Commodity, ISO NE**
3. Energy Command Center
   - **Project Goals**
   - **Implementation**

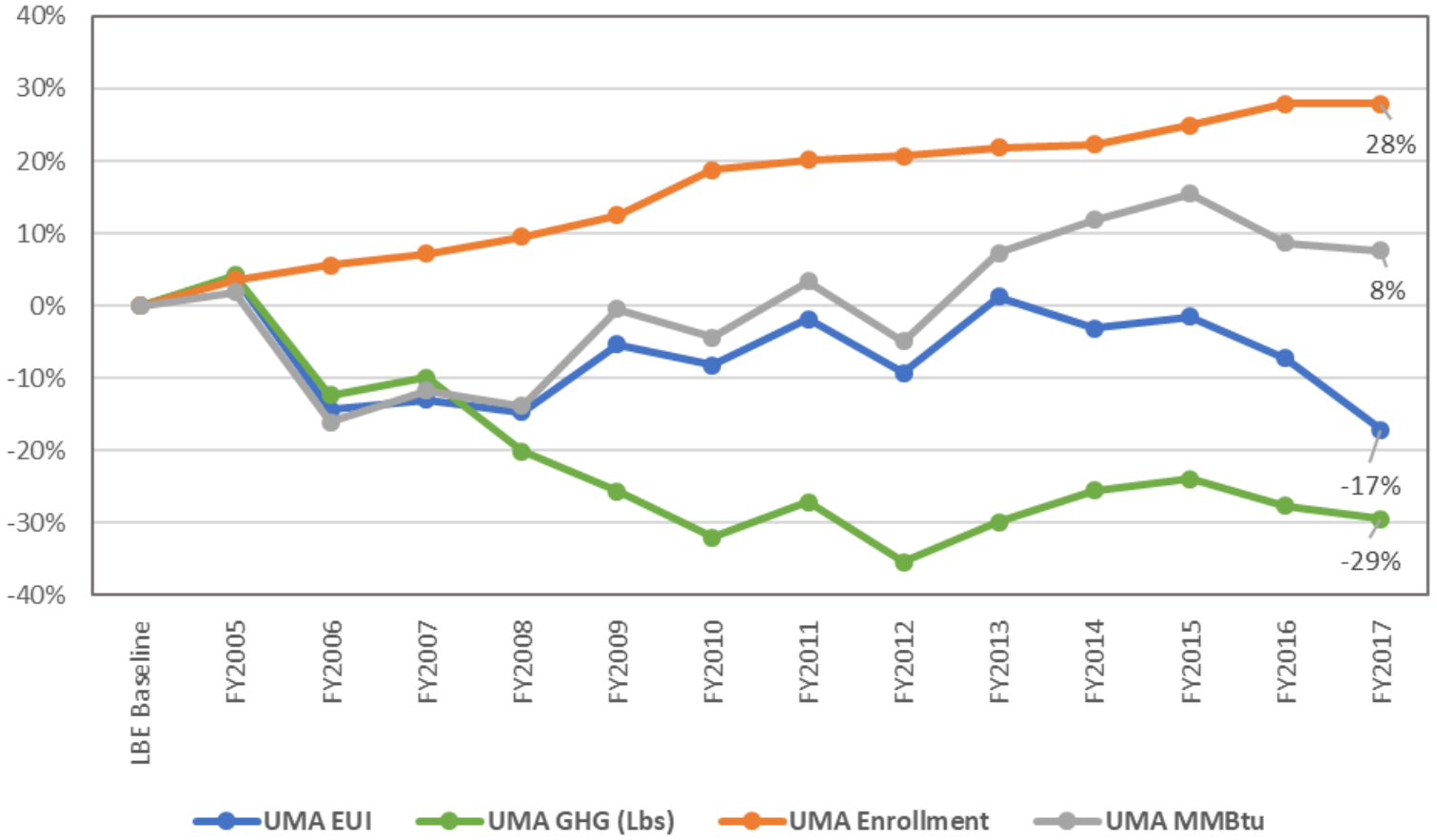
CAMPUS BACKGROUND & CONTEXT

Competitive Energy SERVICES

OVERVIEW | Despite Growth, Costs are Declining



OVERVIEW | Despite Growth, Carbon is Shrinking



OVERVIEW | Notable Projects

- 15 MW CHP Installation
- LNG Installation
- Energy Master Plan
- Onsite Solar
  - Parking Canopies/Rooftops- 5.6 MW
- Battery Storage
- Energy Command Center
- Continuous Commissioning

OVERVIEW | Battery Storage

- 1 MW/4MWh lithium ion battery to be installed by Tesla and operated by UMass Amherst
- Operations aim to reduce peak marginal capacity, help optimize onsite solar, and provide resiliency
- Comprehensive research initiative to be conducted by the UMass Clean Energy Extension
- Tesla to contribute $80,000 for educational initiatives

PROJECT TEAM

University of Massachusetts Amherst, University of Massachusetts Clean Energy Extension, Tesla Energy, Competitive Energy Services

FUNDING AMOUNT

Requested ACES grant would cover 47% of $2.42 million total cost

SELECTION PROCESS

Extensive RFP and review process to select Tesla as project partner

1. Demonstrate value of coincident peak demand management
2. Optimize integration of renewable distributed generation
3. Educate Massachusetts' next generation of clean energy experts

PEAK DEMAND MANAGEMENT

UMass Amherst is in a unique position to demonstrate value of reducing demand to limit additional generation and transmission capacity need

RENEWABLES INTEGRATION

Campus has 15 MW of cogeneration and 5.6 MW of solar PV in service, resource integration poses operational constraints

RESILIENCY

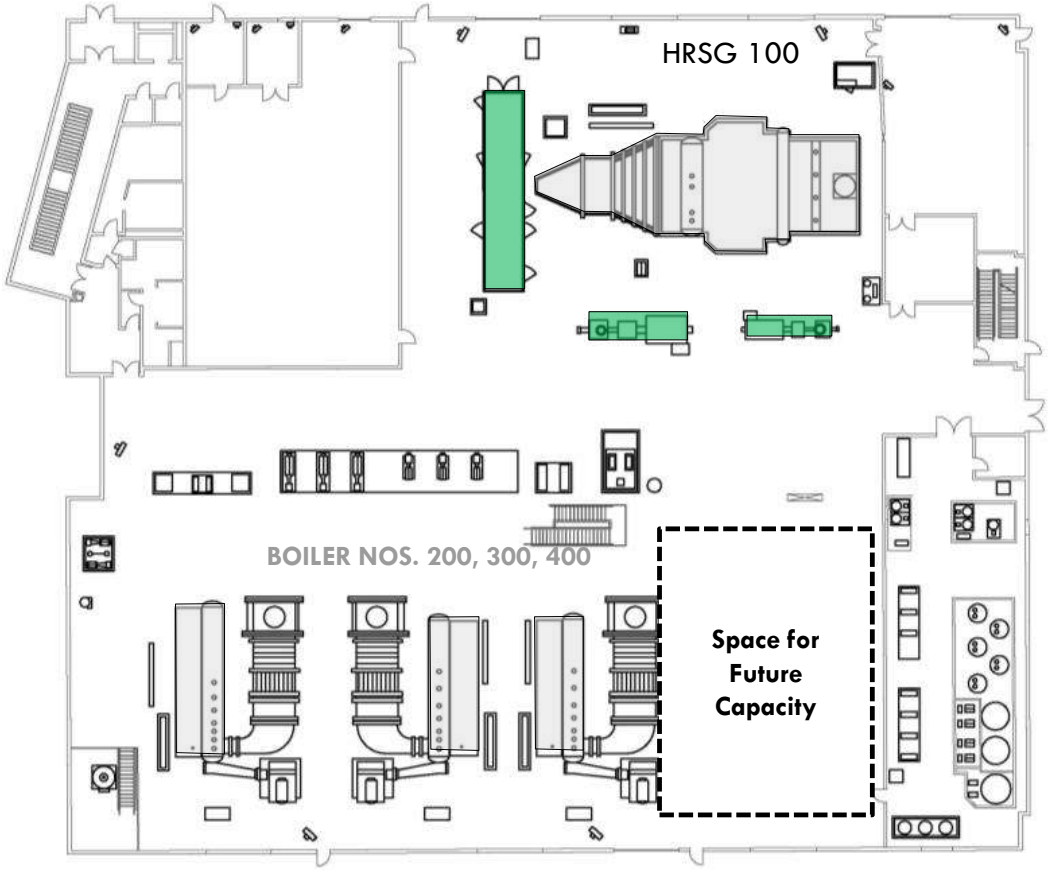
Battery to feed campus distribution system serving the Mullins Center, a regional emergency shelter for Hampshire County

BOILER CAPACITY

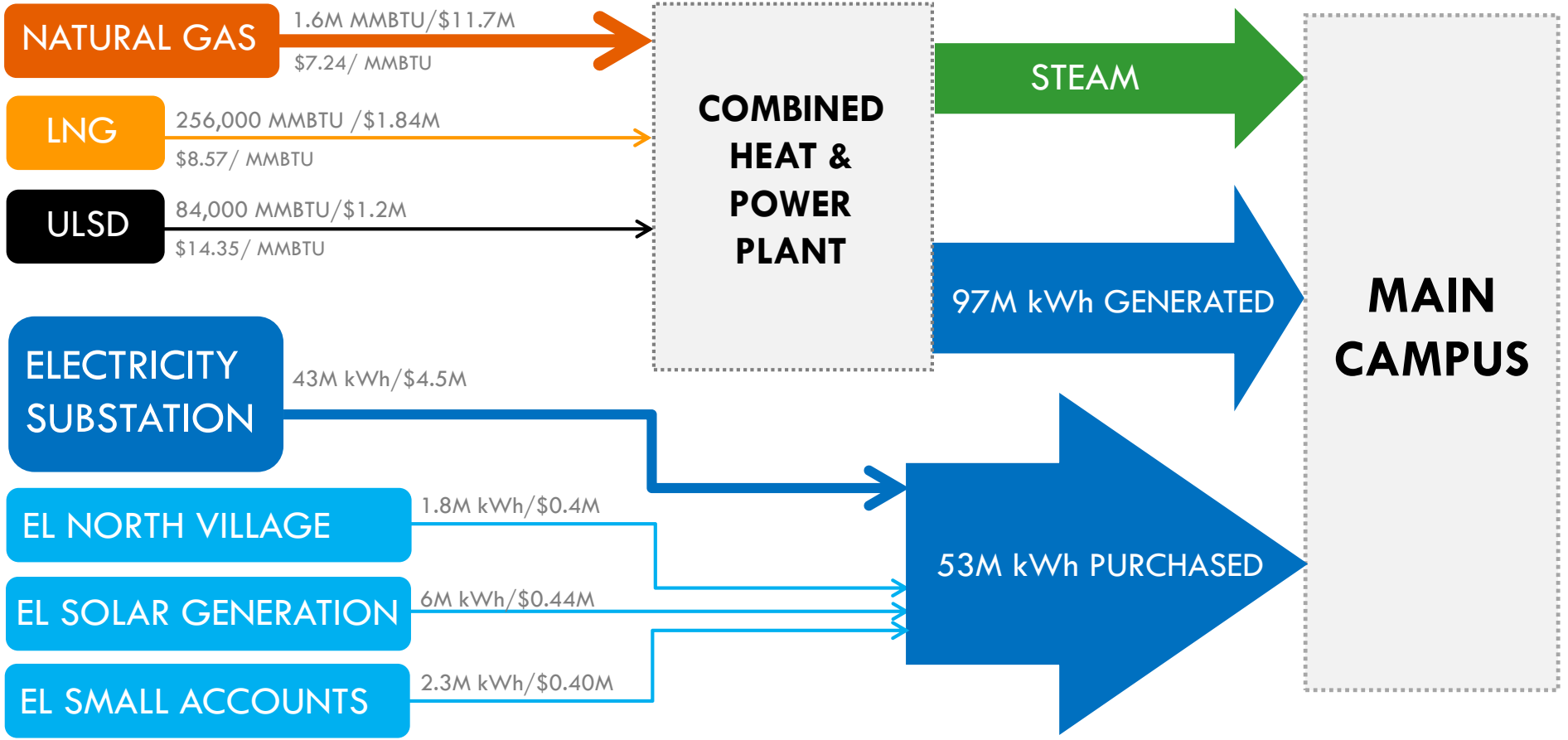
HRSG/ Boiler No.	Boiler Capacity (pph)	Firm Capacity (pph)	Second Fuel
100	100,000	100,000	---
200	125,000	---	Diesel
300	125,000	125,000	Diesel
400	125,000	125,000	Diesel
Total	475,000	350,000	---

TURBINE SUMMARY

Turbine No.	Turbine Type	Capacity (kW)
G-1	Comb. Turb.	10,000
STG-1	Steam Gen.	2,000
STG-2	Steam Gen.	4,000
Total	---	16,000



OVERVIEW | Main Campus FY17 Energy Forecast



UMA ENERGY COST ANATOMY

Supply & Utility Breakdown

Competitive Energy SERVICES

COST ANATOMY | 2 Components

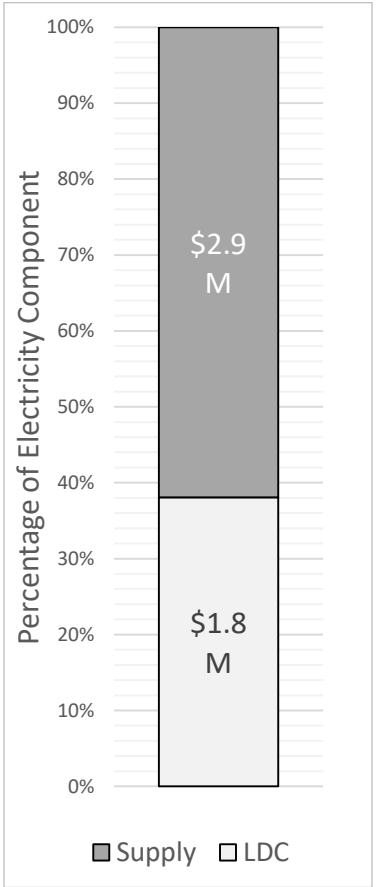
SUPPLY

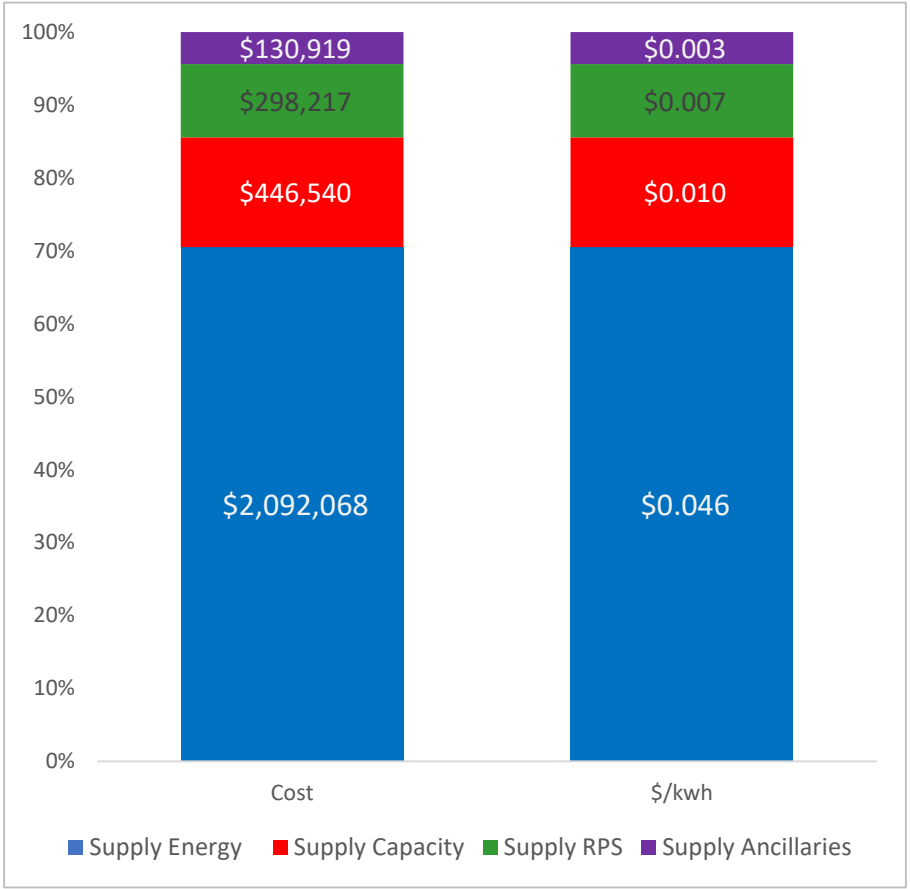
The SUPPLY is the source of the energy. SUPPLY is the commodity, what is bought, sold and traded. The supplier generates the power and transmits it to the power grid. This also includes ISO-NE costs for the forward capacity market along with the ancillary services.

TRANSMISSION & DELIVERY

The Utility, or Local Distribution Company (LDC), takes the power off the grid and transports it to the consumer. These TRANSMISSION & DELIVERY (T&D) charges make up the other half of your bill.

COST ANATOMY | What Makes Up Your Supply Price?





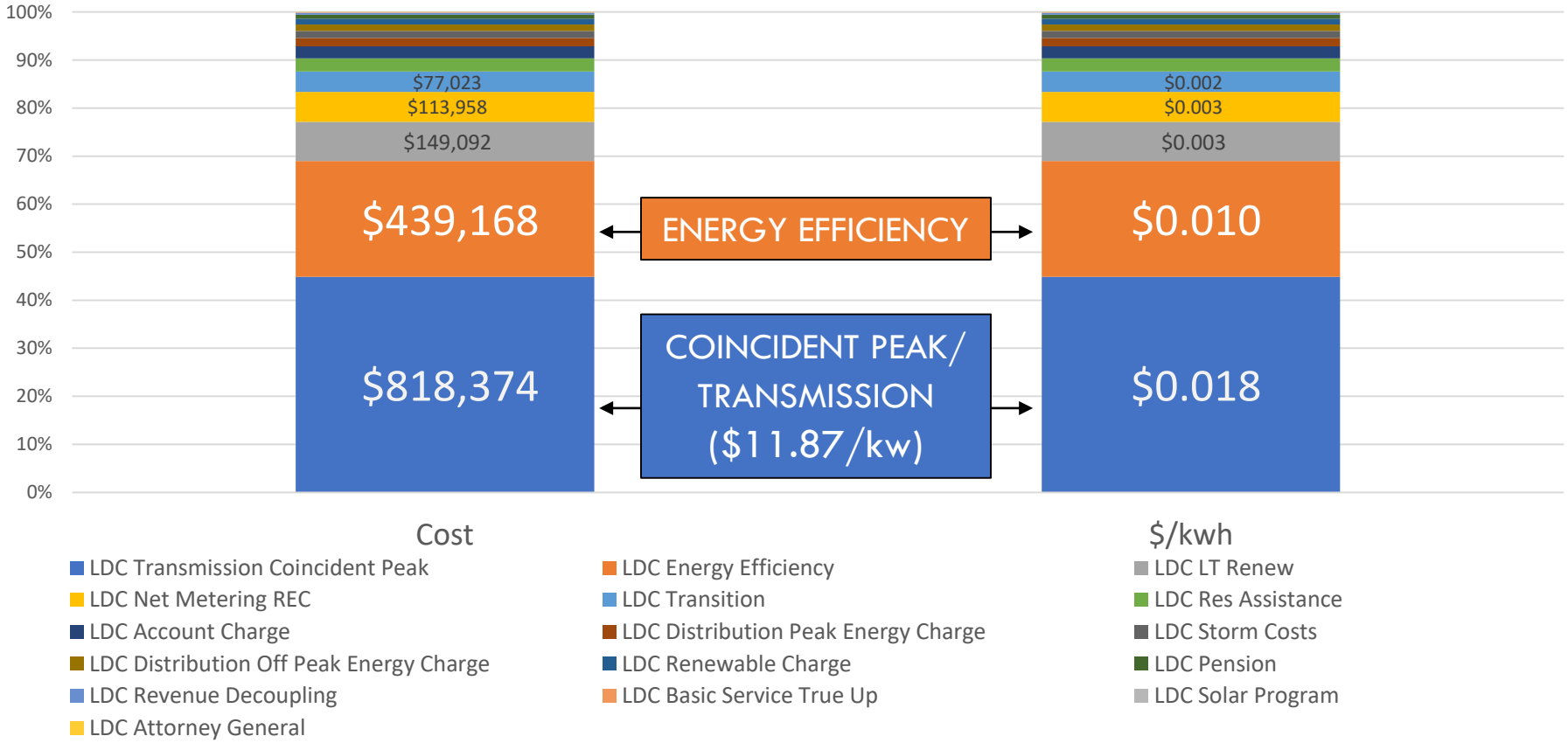
ANCILLARIES: Administrative charges billed to load-serving entities by the NEISO to operate grid safely and reliably

RENEWABLE PORTFOLIO STANDARDS (RPS): Mandates set by individual states for load-serving entities to purchase a certain amount of renewable energy; determined by state regulated compliance percentages and the financial market for renewable energy certificates (RECs).

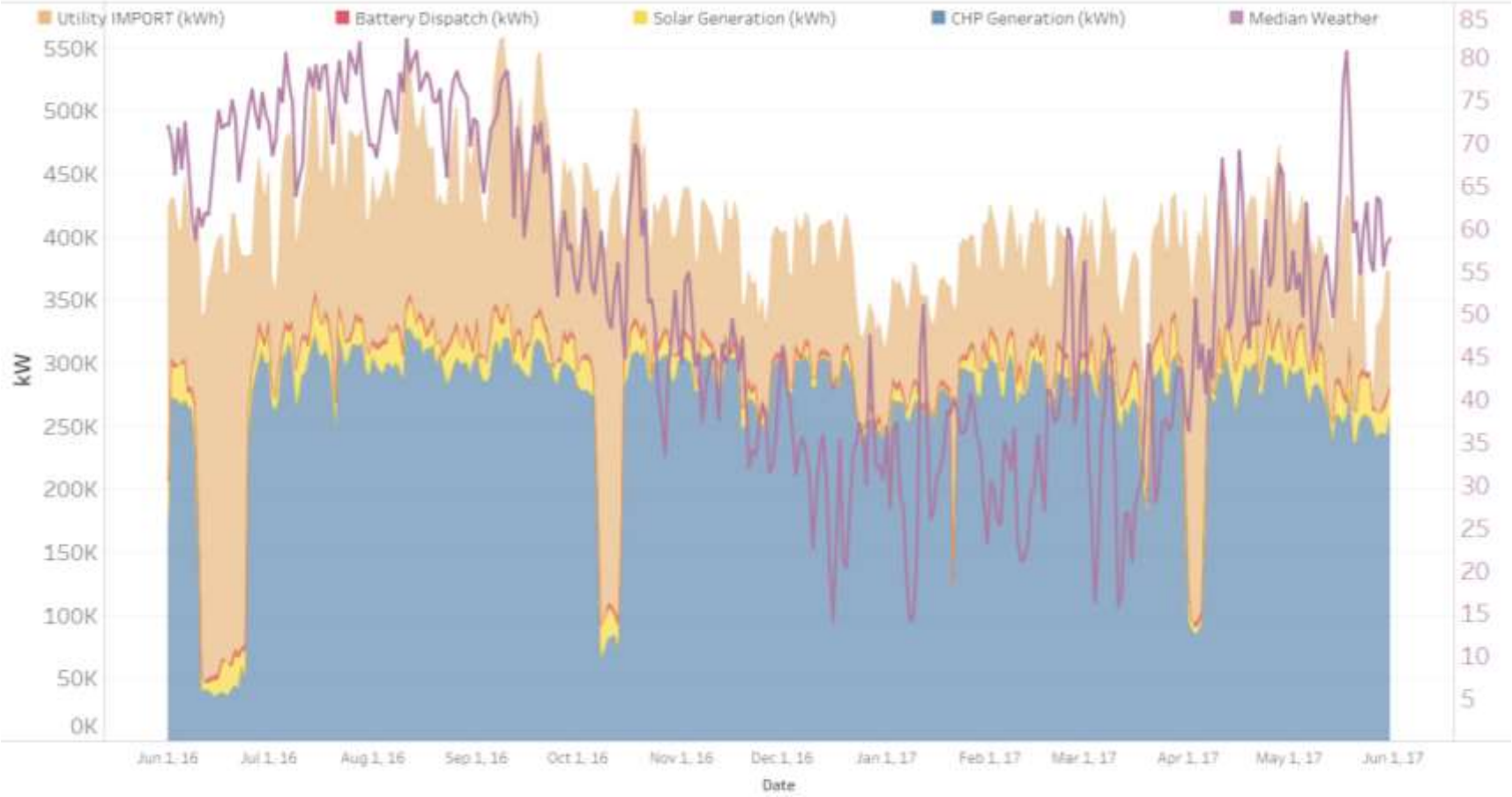
CAPACITY: Determined by NEISO scaling factors, price auctions and customer's capacity tag. Designed to ensure grid reliability and ensure enough generation available to the region.

ENERGY: The cost of procuring the actual electrons transmitted through the T&D lines.

COST ANATOMY | What Makes Up Your LDC Price?



COST ANATOMY | UMA FY17 Energy Profile



COST ANATOMY | LDC Coincident Peak

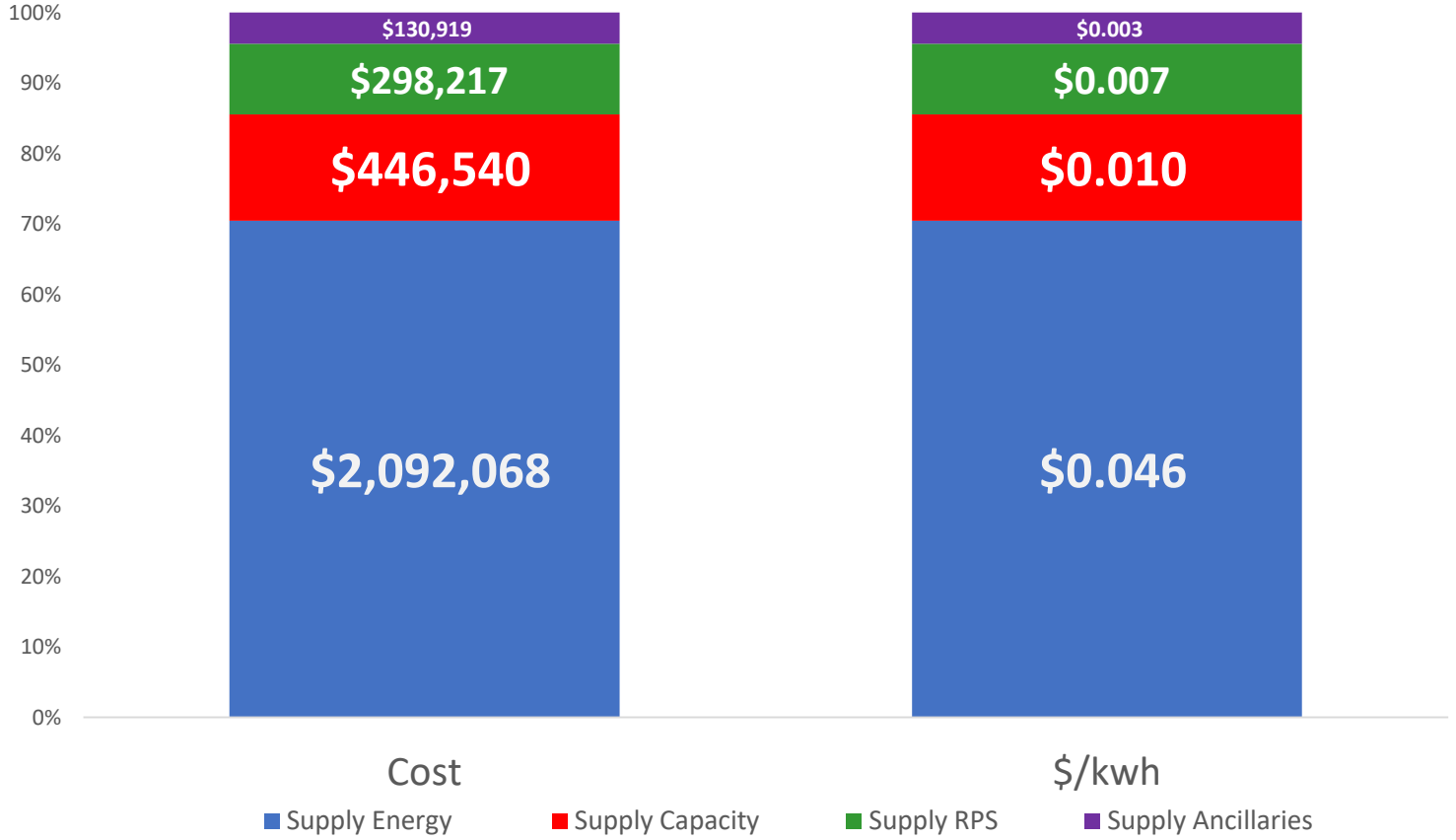
COST ANATOMY | LDC Coincident Peak- Cost Mitigation

UMASS AMHERST Competitive Energy SERVICES

Date	Day of Week	HE	UMA Total Load	UMA WMECO IMPORT (kW)	UMA Solar Generation (kW)	UMA CHP Generation (kW)	UMA Battery Dispatch (kW)
6/29/2016	Wednesday	17	18,542	5,055	370	13,487	1,000
7/22/2016	Friday	17	21,749	7,045	1,144	14,704	1,000
8/12/2016	Friday	15	23,587	8,710	2,759	14,877	1,000
9/9/2016	Friday	16	24,847	11,308	368	13,539	1,000
10/27/2016	Thursday	18	18,627	4,692	-	13,936	1,000
11/21/2016	Monday	19	14,850	3,583	-	11,267	1,000
12/15/2016	Thursday	18	18,490	4,525	-	13,965	1,000
1/9/2017	Monday	18	15,326	3,650	-	11,676	1,000
2/9/2017	Thursday	19	15,101	4,439	-	10,662	1,000
3/15/2017	Wednesday	19	14,902	3,606	-	11,295	1,000
4/6/2017	Thursday	17	16,939	4,839	1,273	12,099	1,000
5/18/2017	Thursday	18	17,787	7,493	127	10,294	1,000

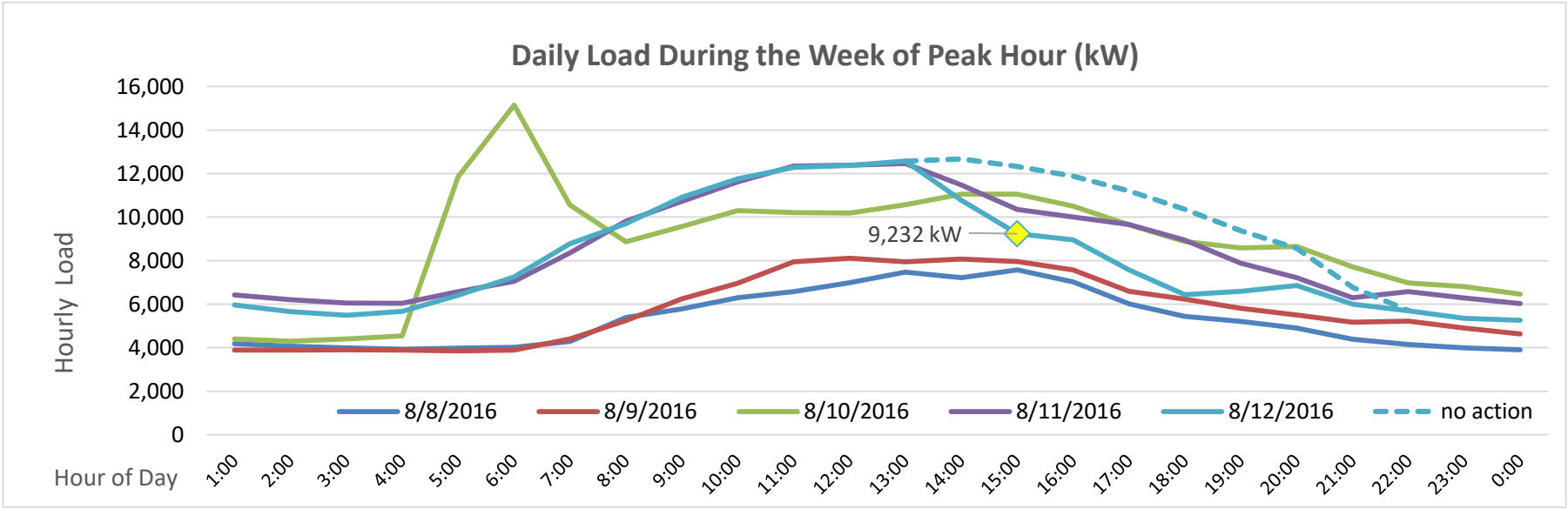
Unit/Scenario	No Cogen	Status Quo	Solar Reduction	CHP Reduction	Battery Reduction
Total (Kw)	220,746	68,945	6,041	151,802	12,000
$/Kw	$ 11.87	$ 11.87	$ 11.87	$ 11.87	$ 12.87
Total Costs ($)	$ 2,620,260	$ 818,374	$ 71,701	$ 1,801,886	$ 154,440
$/kwh		$ 0.0182	$ 0.0016		$ 0.0034

COST ANATOMY | Supply Costs



COST ANATOMY | Supply FCM Cost Mitigation

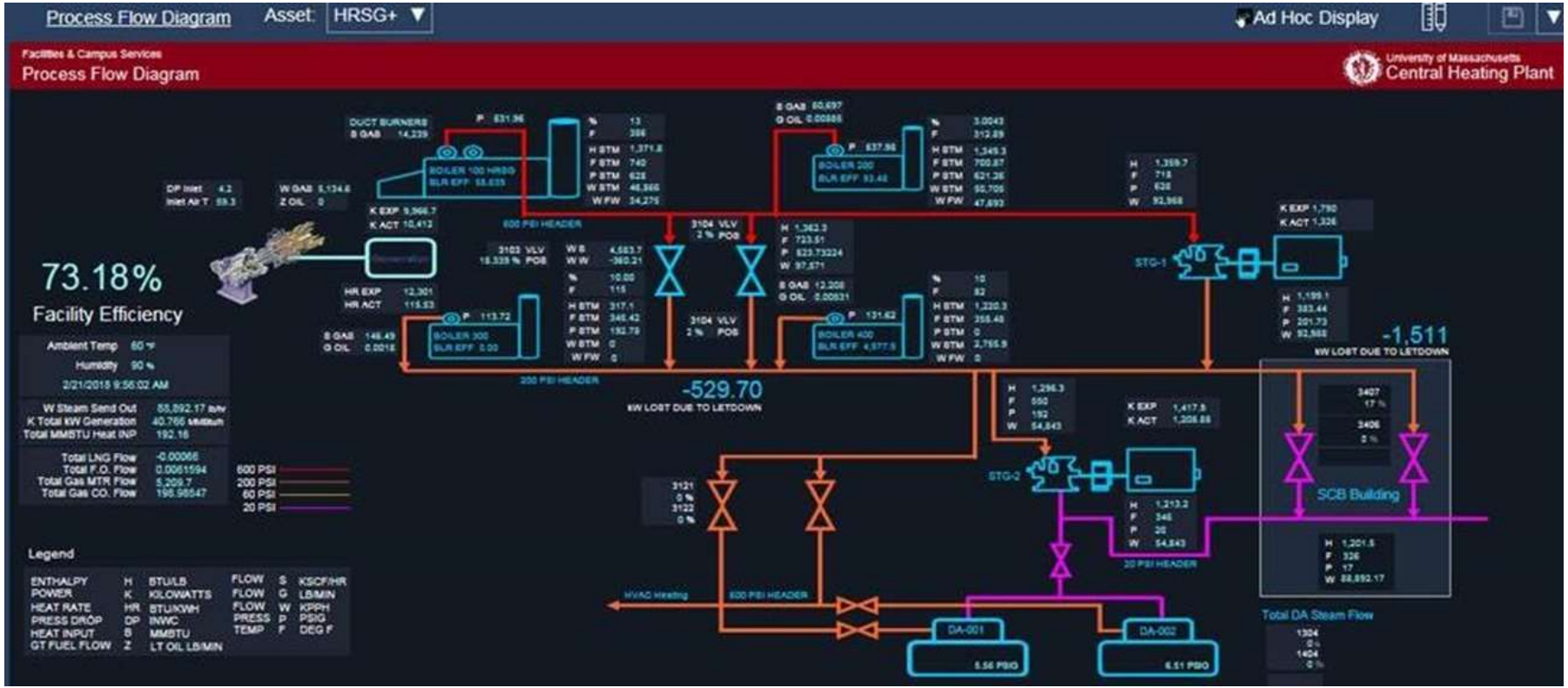
Year	Applicable Time Range	Settlement Rate ($/kW/month	Reserve Margin	Effective Rate ($/kW/month)	UMASS AMHERST Peak (kW)	Estimated Annual Capacity Cost	Monthly Capacity Costs	Capacity Costs ($/kwh)	Potential Savings per 1 MW Reduction
Peak '15	6/1/2016 - 5/31/2017	$2.88	56%	$4.49	8,811	$475,033	$39,586	$0.0105	$53,914
Peak '16	6/1/2017 - 5/31/2018	$7.44	49%	$11.09	9,232	$1,228,107	$102,342	$0.027	$133,027
Peak '17	6/1/2018 - 5/31/2019	$9.29	53%	$14.21	4,621	$788,178	$65,682	$0.017	$170,564
Peak '18	6/1/2019 - 5/31/2020	$7.03	51%	$10.62	6,732	$857,546	$71,462	$0.019	$127,384
Peak '19	6/1/2020 - 5/31/2021	$9.55	51%	$14.42	5,732	$991,900	$82,658	$0.022	$173,046
Peak '20	6/1/2021- 5/31/2022	$5.30	51%	$8.00	5,732	$550,478	$45,873	$0.012	$96,036
Peak '21	6/1/2022- 5/31/2023	$4.63	51%	$6.99	5,732	$480,890	$40,074	$0.011	$83,896



ENERGY COMMAND CENTER

Competitive Energy SERVICES

ENERGY COMMAND CENTER



ECC | Objectives & Use Cases

1. Operate plant more effectively and efficiently
2. Deliver better visibility to operators
3. Add building level data to recalibrate building operations

FUEL ARBITRAGE

With multiple fuels onsite, and live market data, the Energy Command Center will make arbitrage opportunities apparent.

OPERATIONAL AWARENESS

Intuitive dashboards and consolidated data allows operators to have more insight into how their plant is operating.

BUILDING DIAGNOSTICS

Providing whole building level data and internal building sensor data will provide actionable data to identify issues in real time.

CENTRAL HEATING PLANT


ONSITE LNG STATION

TRACKED MARKET DATA

1. Electricity (LMP Day Ahead + Real Time)
2. Natural Gas Day Ahead
3. Static Contracted Prices and Volumes

CHARGE OR DISCHARGE BATTERY

Monitoring the cost of electricity and campus demand, operators can choose the best time to dispatch this resource.

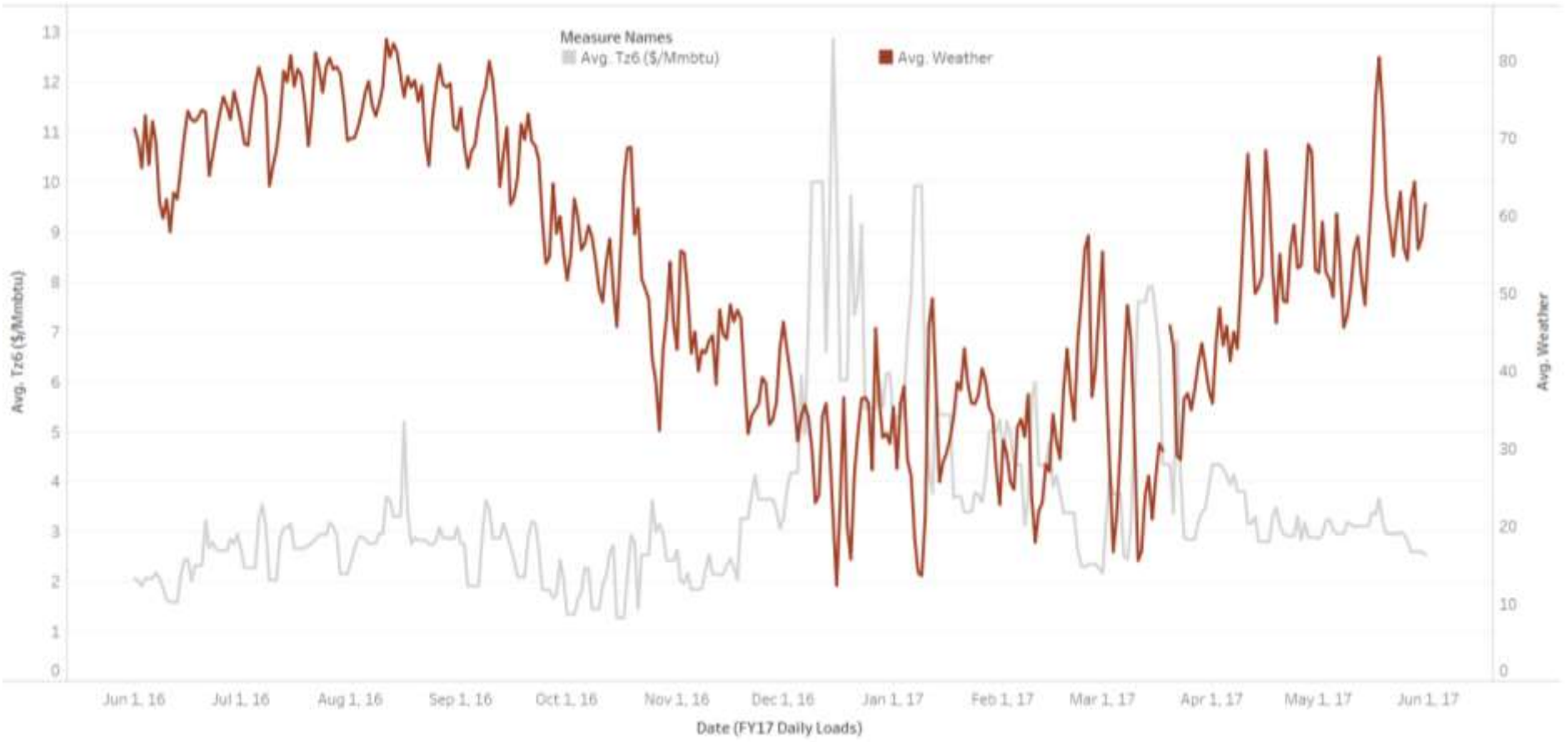
MAKE OR BUY ELECTRICITY

During market spikes, it may be more effective to back down generation and purchase from the grid.

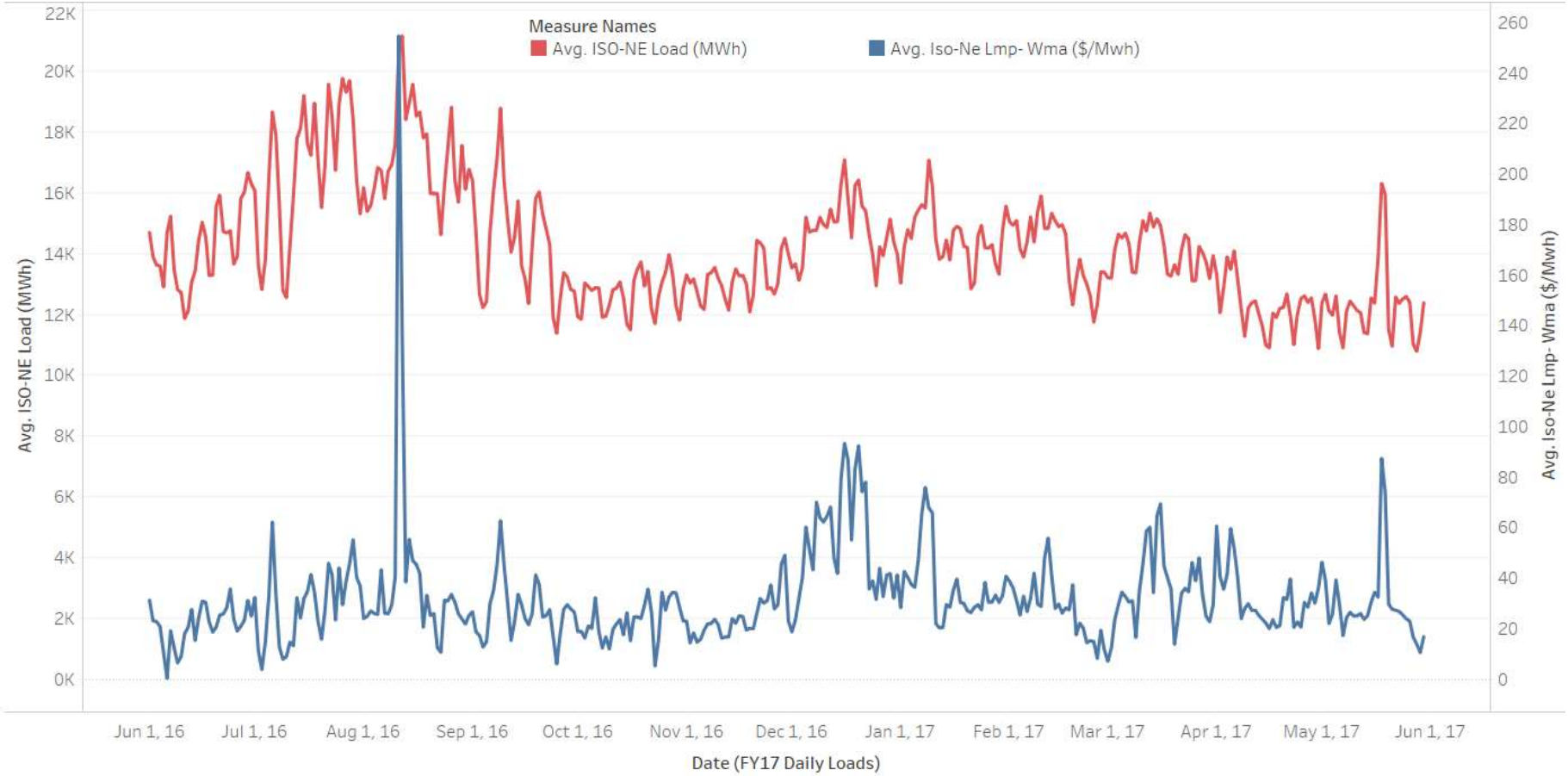
FUEL ARBITRAGE

With Natural Gas, LNG, and Oil at the plants disposal, choosing the right fuel to use is apparent.

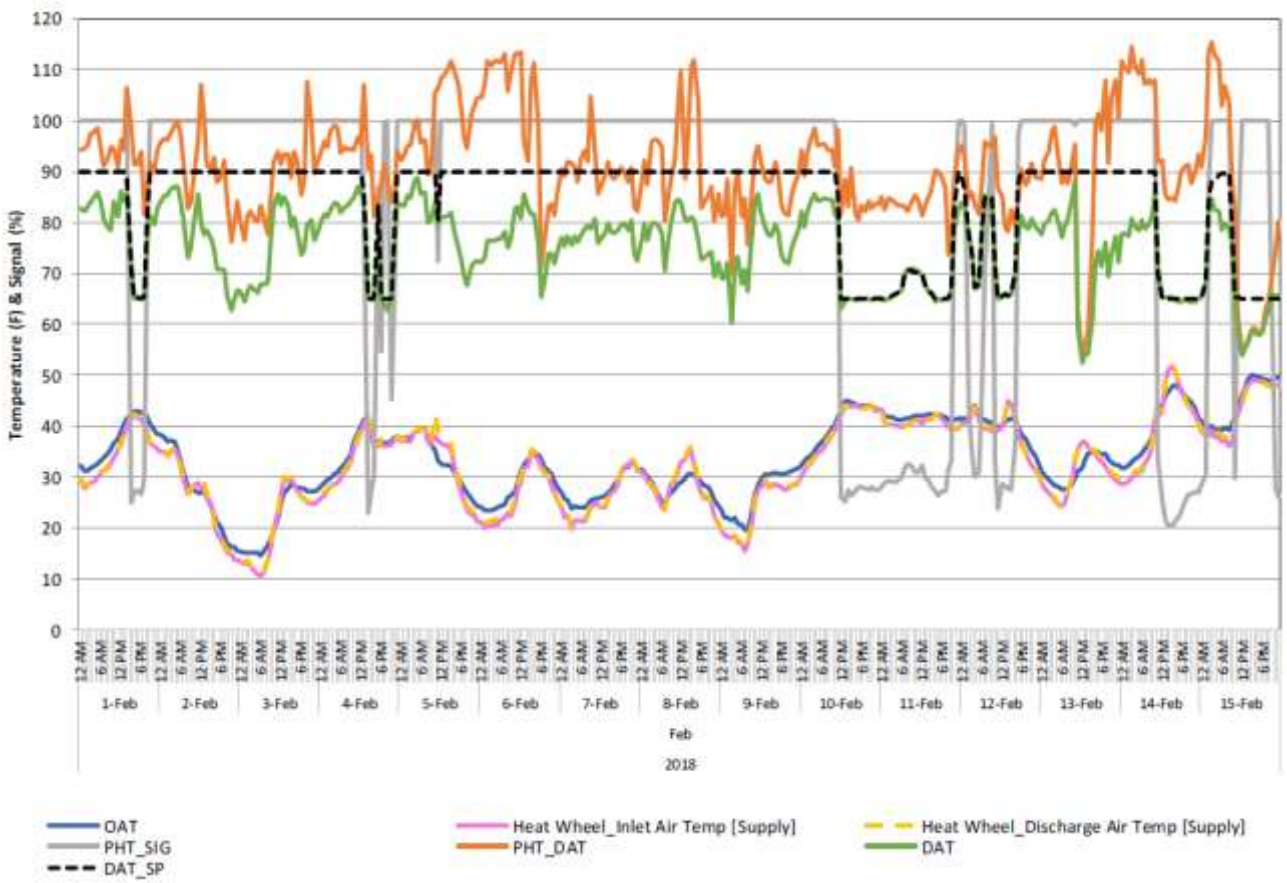
ECC | Natural Gas Daily & Weather



ECC | ISO-NE Load & LMP Pricing



ECC | Morrill- Heat Recovery Wheel (HRW)



- ERV2 is 100% Outside air, constant volume unit and runs 24/7 and contains a HRW
- Data shows HRW in not turning when the heat when command and status points are ON.
- Missed opportunities to preheat incoming air
- **Estimated Annual Savings:**
  - $16,803
  - 933 Mlbs

THANK YOU

Competitive Energy SERVICES