

TESLA

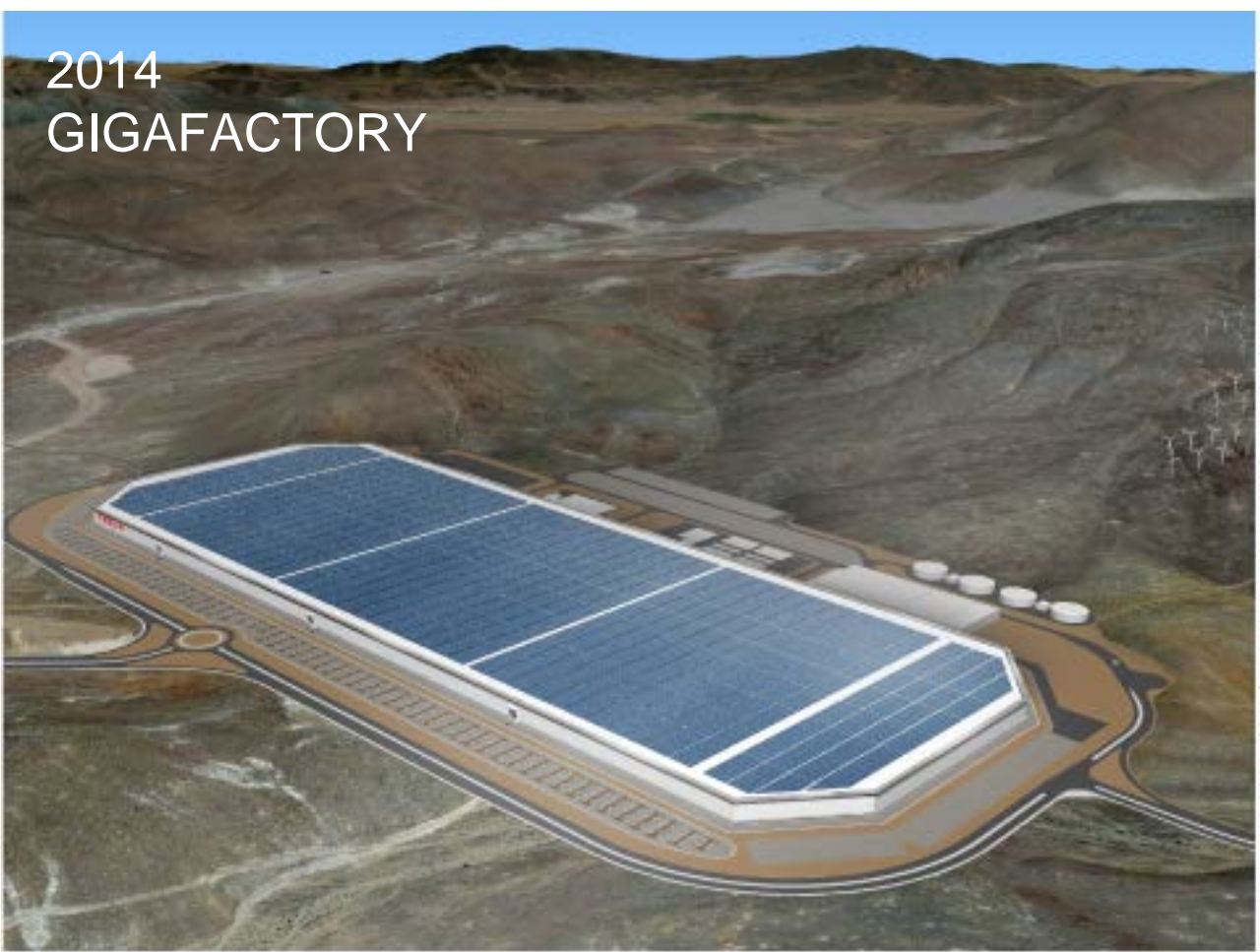
RES West Africa| Dakar
2019, December 2nd

OUR MISSION

Accelerate the world's transition to sustainable energy



TIMELINE OF INNOVATION



TESLA PRODUCT SUITE



Vehicles



Semi



Charging



Solar



Powerwall



Powerpack



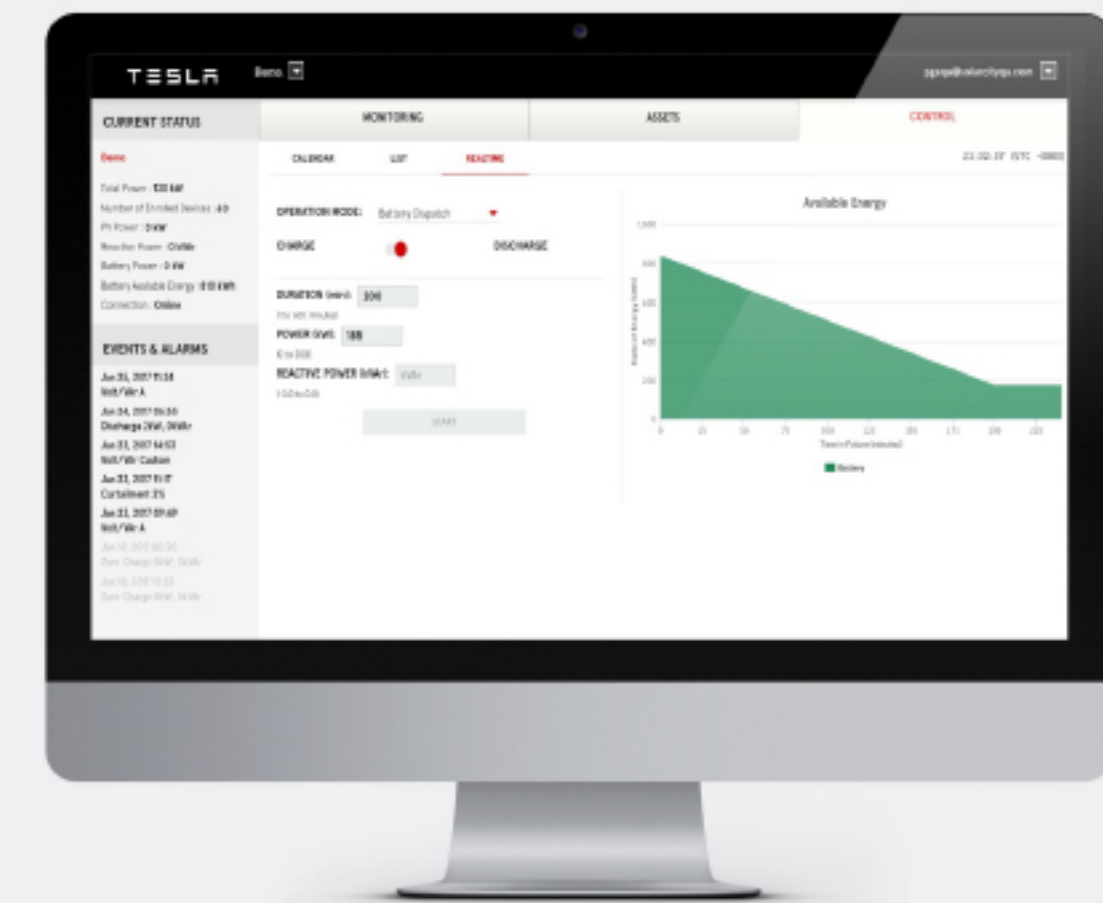
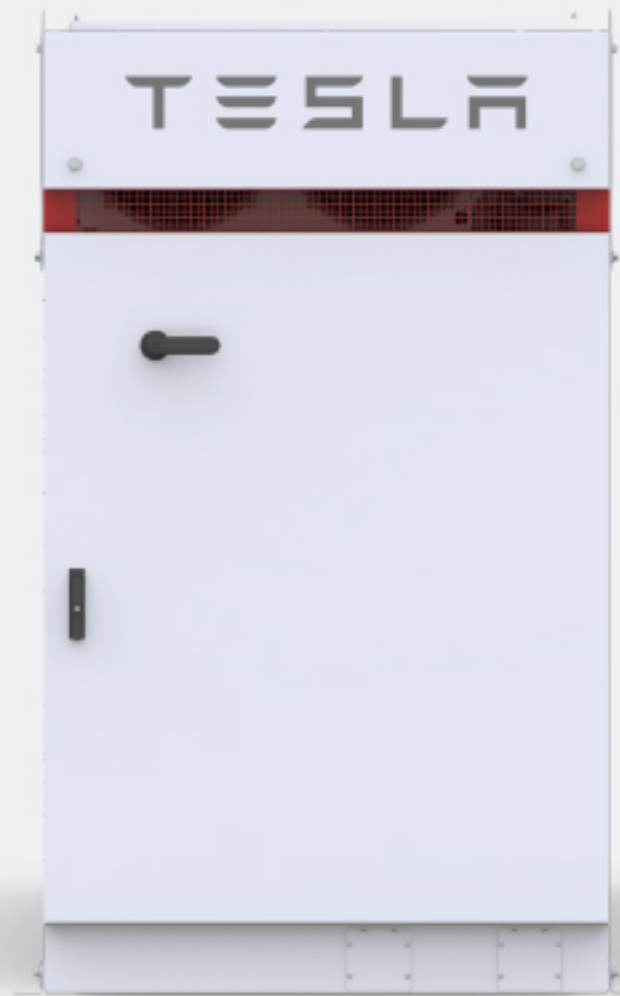
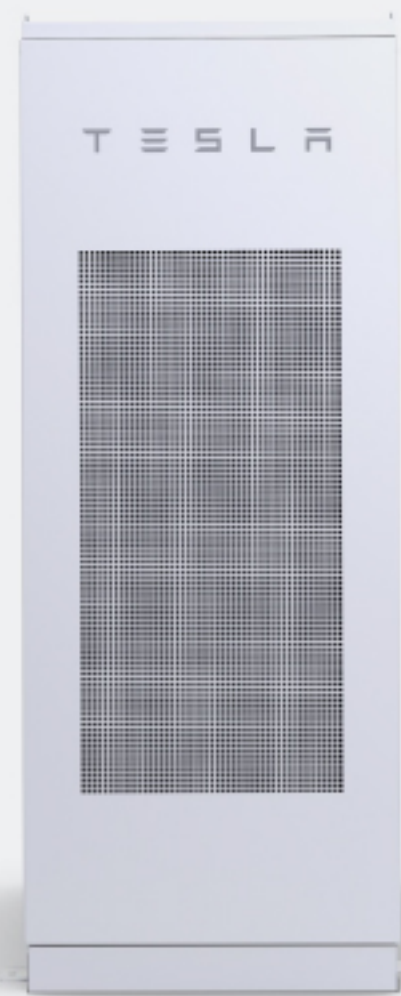
Software



Megapack

Tesla Energy Products

TESLA IS YOUR SINGLE-SOURCE PROVIDER OF THE ENTIRE ENERGY STORAGE SYSTEM



Powerpack/Megapack

LITHIUM-ION BATTERIES
LIQUID THERMAL CONTROL
ISOLATED DC-DC CONVERTER

Inverter

BI-DIRECTIONAL
TRANSFORMER-LESS
MODULAR
OFF-GRID AND GRID-TIED CAPABLE
99% PEAK EFFICIENCY

Integrated Software

OPTIMIZATION SOFTWARE
BATTERY MANAGEMENT SYSTEM
SITE MASTER CONTROLLER

Remote Monitoring

REAL-TIME MONITORING & CONTROL
REAL AND REACTIVE POWER SERVICES
OPTIMIZED DISPATCH AND MARKET PARTICIPATION

STORAGE IS PROVEN ACROSS A RANGE OF APPLICATIONS



Residential

Commercial

Utility

Microgrid

Residential

Commercial

Utility

Microgrid

Residential

Commercial

Utility

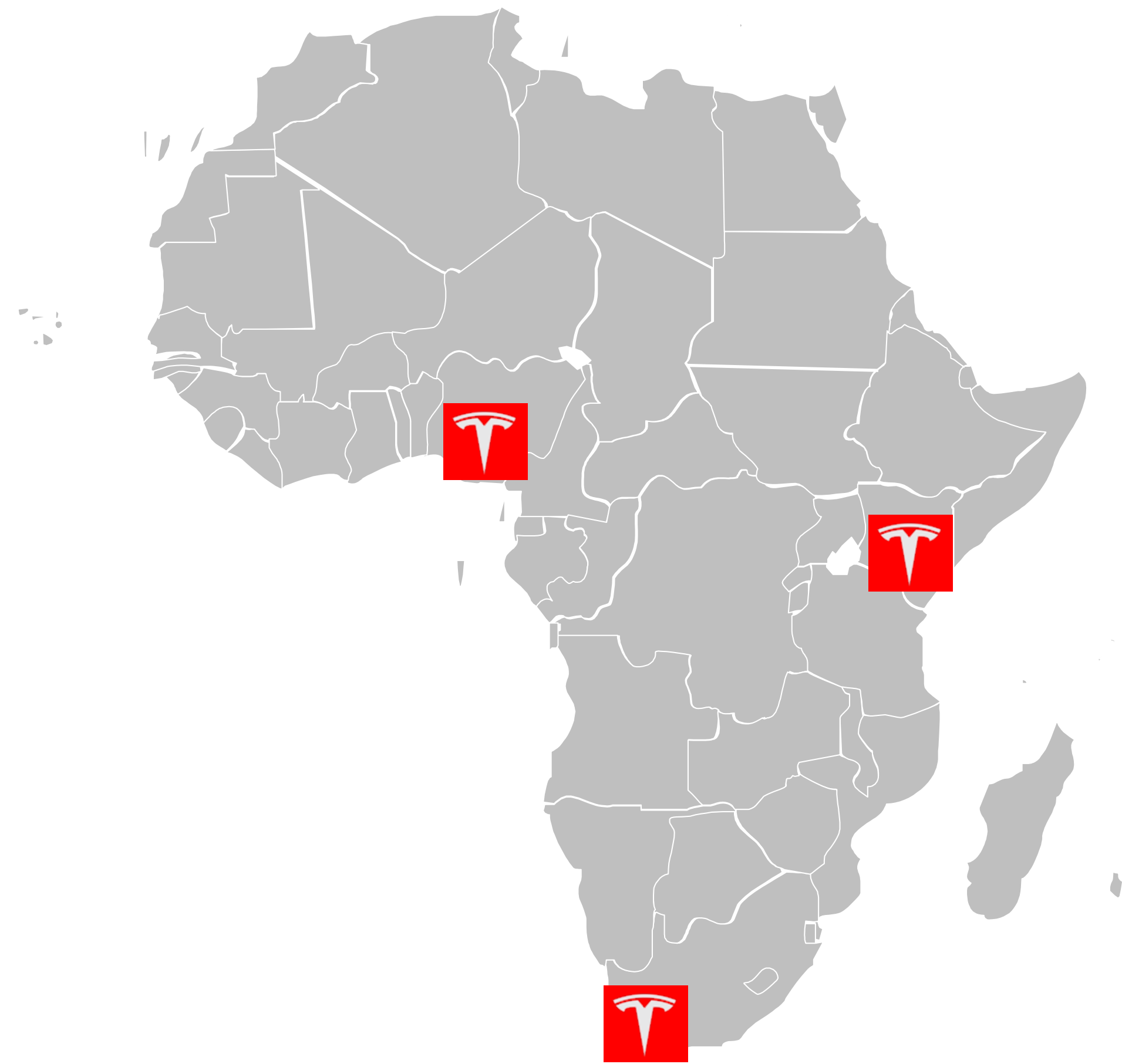
Microgrid

TESLA IN AFRICA

50+ systems
contracted

20+ systems
deployed

15+
countries

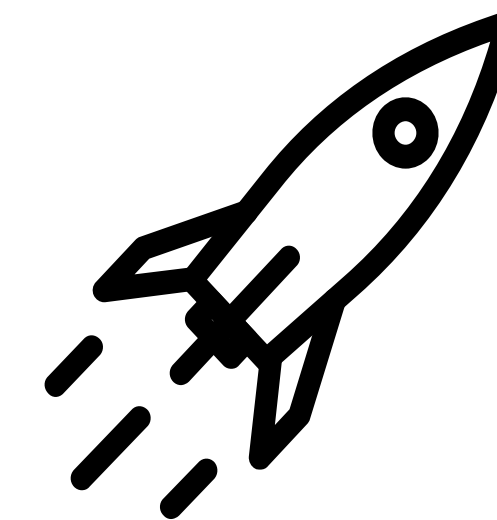
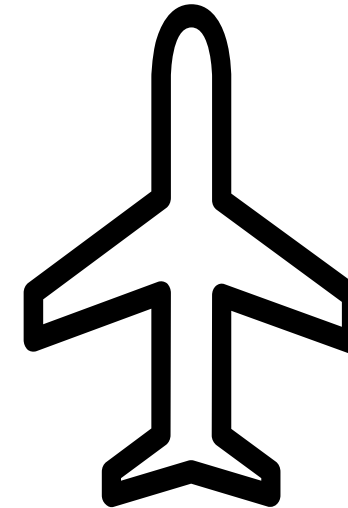
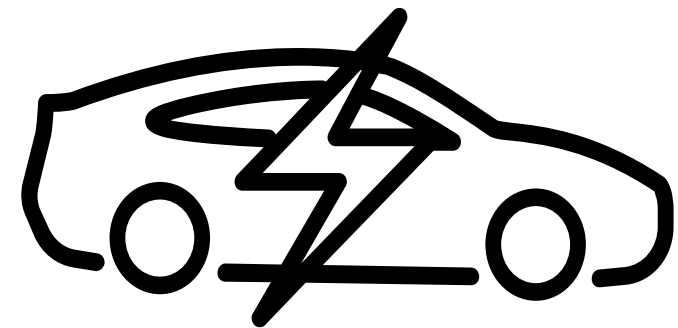


1st system
deployed in March
2017

Microgrid diesel
abatement &
backup

70% average diesel
usage reduction

TESLA AFRICAN APPROACH



1 – Proof of concept <1MWh

Microgrid system combined with solar to avoid/reduce thermal engines running.

Extremely remote facilities where energy is rare. Ex: Health and Hospitality facilities.

2 – C&I 1-10MWh

Microgrid and back-up system combined or not with solar to avoid and reduce generators.

Remote facilities and/or with unreliable energy access. Ex: Rural Electrification and factories.

3 – Utility scale >10MWh

Grid services, T&D deferral, ↗ RE penetration and Peaker plants replacement.

Ex: Major substation, collocated with large generation asset.

TESLA HAS AN ONLINE SIMULATION UI FOR OFF-GRID MICROGRIDS

Site and System Inputs

Power kW 1d 1w 1m 6m 1y all

Jan 2015 Mar 2015 May 2015 Jul 2015 Sep 2015 Nov 2015

Power kW

Day of Year

Load Specifications

Load Escalation Rate %

Min Load Met %

Solar PV Sweep **Single**

Generation Profile **Upload**

csv/xls/xlsx in table or list format.

or drag file(s)

kw Units

Rated Capacity kw-AC

DC to AC Ratio

Replacement Year yr

Degradation Rate %/yr

Economics

Equipment Cost \$/W-DC

Operating Cost \$/kW-DC-yr

Replacement Cost % Eqp cost

EPC Cost \$/W-DC

Dispatch Simulation

interval_data_400_528_845_250 - Excel

	A	B	C	D	E	F	G	H	I	J	K
1	PV AC kW	Storage kW	Storage kW	Genset ma	Cycles	Avg. Hours per Day at High Voltage					
2		400	528	845	250	212	1				
3		Load	Solar Prod	Solar Direc	Solar Char	Solar Expo	Solar Curt	Battery Po	Battery Ch	Battery D	Battery
4	1/1/2015 0:00	116.8	0	0	0	0	0	116.8	0	116.8	728
5	1/1/2015 1:00	113.02	0	0	0	0	0	113.02	0	113.02	615.
6	1/1/2015 2:00	109.43	0	0	0	0	0	109.43	0	109.43	505.
7	1/1/2015 3:00	112.34	0	0	0	0	0	112.34	0	112.34	393.
8	1/1/2015 4:00	109.91	0	0	0	0	0	109.91	0	109.91	283
9	1/1/2015 5:00	112.53	0	0	0	0	0	112.53	0	112.53	170.
10	1/1/2015 6:00	115.54	12.17	12.17	0	0	0	103.37	0	103.37	67
11	1/1/2015 7:00	117.97	69.77	69.77	0	0	0	48.2	0	48.2	15
12	1/1/2015 8:00	126.02	168.34	126.02	42.32	0	0	-42.32	42.32	0	55.
13	1/1/2015 9:00	129.71	196.4	129.71	66.69	0	0	-66.69	66.69	0	112
14	1/1/2015 10:00	129.32	217.75	129.32	88.43	0	0	-88.43	88.43	0	188.
15	1/1/2015 11:00	125.24	339.29	125.24	214.05	0	0	-214.05	214.05	0	371.
16	1/1/2015 12:00	123.21	329.11	123.21	205.9	0	0	-205.9	205.9	0	547.
17	1/1/2015 13:00	126.21	252.27	126.21	126.06	0	0	-126.06	126.06	0	655.
18	1/1/2015 14:00	133.1	156.67	133.1	23.57	0	0	-23.57	23.57	0	675.
19	1/1/2015 15:00	135.33	159.65	135.33	24.32	0	0	-24.32	24.32	0	6
20	1/1/2015 16:00	132.52	84.54	84.54	0	0	0	47.98	0	47.98	648.
21	1/1/2015 17:00	135.14	19.37	19.37	0	0	0	115.77	0	115.77	532.
22	1/1/2015 18:00	129.51	0	0	0	0	0	129.51	0	129.51	402.
23	1/1/2015 19:00	132.23	0	0	0	0	0	132.23	0	132.23	270.

Optimal Configurations

Show Graph	Best	PV AC kW	Bat kW	Bat kWh	Self Sufficiency	Payback	IRR	NPV	LCOE	Genset Size	% Load Met
<input type="radio"/>	Self Sufficiency	500	422	676	100%	4.7 Years	23%	\$1,047,386	\$0.42/kWh	200	100%
<input type="radio"/>	Payback	125	106	169	51%	2.5 Years	43%	\$818,913	\$0.48/kWh	200	100%
<input type="radio"/>	IRR	104	106	169	47%	2.5 Years	43%	\$711,665	\$0.51/kWh	200	100%
<input type="radio"/>	NPV	291	422	676	96%	3.7 Years	29%	\$1,204,962	\$0.38/kWh	200	100%
<input type="radio"/>	LCOE	291	422	676	96%	3.7 Years	29%	\$1,204,962	\$0.38/kWh	200	100%

Cash Flow Analysis

dashboard

INPUTS

Diesel

Grid Interconnection Size Cost \$ Utility bill Annual charge Cost \$

Genset roster - no storage

Number	Model	Real power kW
genset 1	genset 1	50
genset 2	genset 2	50
genset 3	<insert name>	
genset 4	<insert name>	
genset 5	<insert name>	
genset 6	<insert name>	
Total	2	100

Capex

	\$/USD	\$/kWh
Storage	\$ 442,320	442,320
Solar	\$ 206,209	390,209
Genset	\$ 150,000	90,000
Grid	\$ -	-
Total	\$ 798,529	978,529

LCOE

	\$/USD	\$/kWh
Grid	\$ -	-
Solar PV - produced	\$ 0.094	0.094
Solar PV - utilized	\$ 0.900	0.100
Storage - discharged	\$ 1.226	1.216
Renewables - consumed	\$ 0.254	0.214
Genset	\$ 3.229	0.231
Blended	\$ 0.266	0.266

Storage capex

	\$/USD	\$/kWh
Total commissioning	\$ 20,000	20,000
Microgrid controller	\$ 50,000	50,000
EPC	\$ 60,000	60,000
Step-up transformer	\$ 50,000	50,000
Shipping	\$ 4,529	6,100
Envirole	\$ 295,000	295,000

Run hours

	Generator only	Genset + solar	Renewables only
Jan	Avg 8.03	4.94	11.03
Feb	Avg 8.90	6.12	8.36
Mar	Avg 9.77	7.74	5.48
Apr	Avg 10.43	9.50	4.67
May	Avg 11.74	11.30	3.96
Jun	Avg 13.03	13.03	2.23
Jul	Avg 13.77	13.00	2.23
Aug	Avg 11.68	7.87	4.48
Sep	Avg 10.07	6.93	4.00
Oct	Avg 9.42	6.71	7.87
Nov	Avg 9.30	6.07	9.83
Dec	Avg 8.57	5.50	9.93

SUSTAINABLE TOURISM: GREAT PLAINS MPALA JENA, ZIMBABWE



Off-grid Microgrid

Solar (130 kWp) + Powerpack (106kW | 420kWh)

Commissioned 2018

Safari lodge is now mostly powered by silent, reliable and renewable energy, reducing diesel consumption by ~90%

POWERING REMOTE HOSPITALS: BORNO STATE, NIGERIA



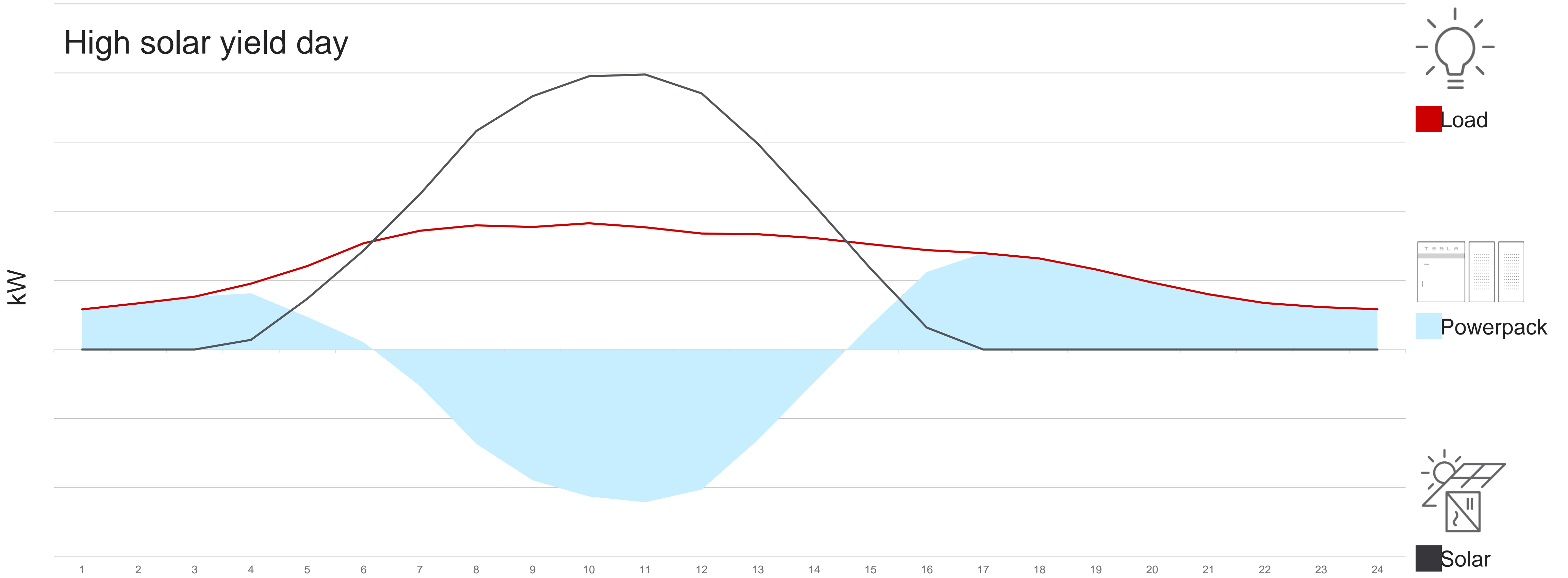
6 x Off-grid Microgrids

Solar (0.8MWp) + Powerpack (0.6 MW | 2 MWh)

Commissioned 2018/2019

Solar, reliable supply of electricity to public health facilities in Northern Nigeria

RENEWABLES ONLY: GRID-FORMING POWERPACK ENABLES HIGH RENEWABLES PENETRATION



Storage charges exclusively from renewables on days with typical solar production

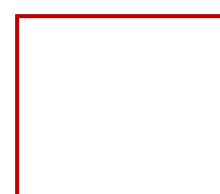
Fossil fuel generators shut down completely while renewables power batteries and load

Renewables are sized well above max load with a Powerpack system sized to absorb all excess generation

MICROGRID ANALYSIS-SIZING

> 80% RENEWABLES WITH 15-25% IRR OVER A 20YR PROJECT VIEW FOR A REMOTE ISLAND (0.50 \$/KWH DIESEL TODAY)

Solar PV	Storage power	Storage energy	Storage Capex	LCOE	Payback	IRR	Renewables fraction	Diesel utilisation
kWAC	kW	kWh	'000 \$	\$/kWh	years	%	% year 1 kWh	year 1 hrs
500	400	1600	650	0.236	4.7	24.0	83% Renewables, 17% Genset	2.568
500	500	2000	825	0.254	5.3	21.0	83% Renewables, 17% Genset	2.514
600	400	1600	650	0.227	4.8	23.3	90% Renewables, 10% Genset	1.492
600	560	2200	910	0.238	5.3	20.7	94% Renewables, 6% Genset	893
700	450	1800	730	0.231	5.1	21.3	96% Renewables, 4% Genset	677
700	500	2000	825	0.234	5.3	20.6	97% Renewables, 3% Genset	473



Scenario recommended to client, giving lowest overall LCOE for site at 90% renewables penetration

POWERING VILLAGES: AREZA AND MAIDMA, ERITREA



2 x Off-grid Microgrids

Solar (2MWp) + Powerpack (0.9MW | 4.2MWh)

Commissioned 2018

Rural electrification – clean, reliable electricity for 40,000 people in 2 villages

POWERING TEA FACTORY: KISUMU, KENYA



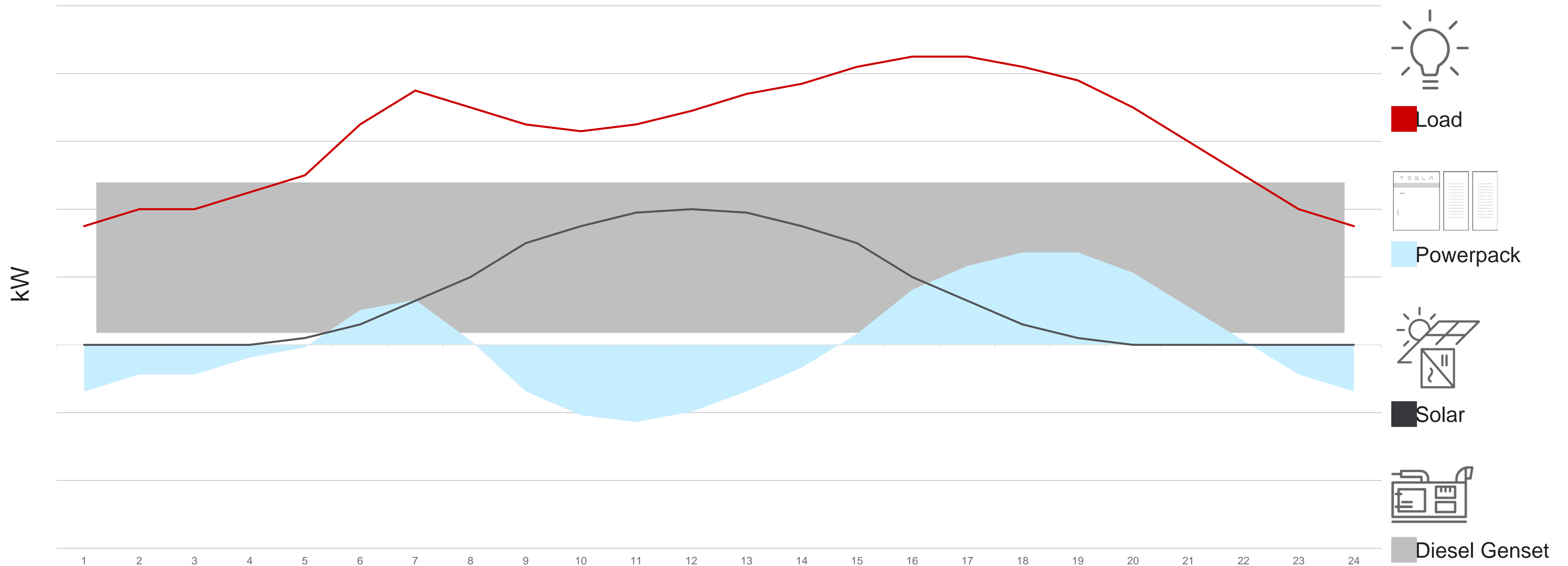
Grid tied grid Microgrid

Solar (1.2MWp) + Powerpack (1MW | 4MWh)

Expected Q1 2020

Solar and reliable electricity for a factory located at the end of the grid.

INTERMITTENCY MANAGEMENT: POWERPACK INTELLIGENTLY BALANCES THERMAL BASELOAD AND RENEWABLES

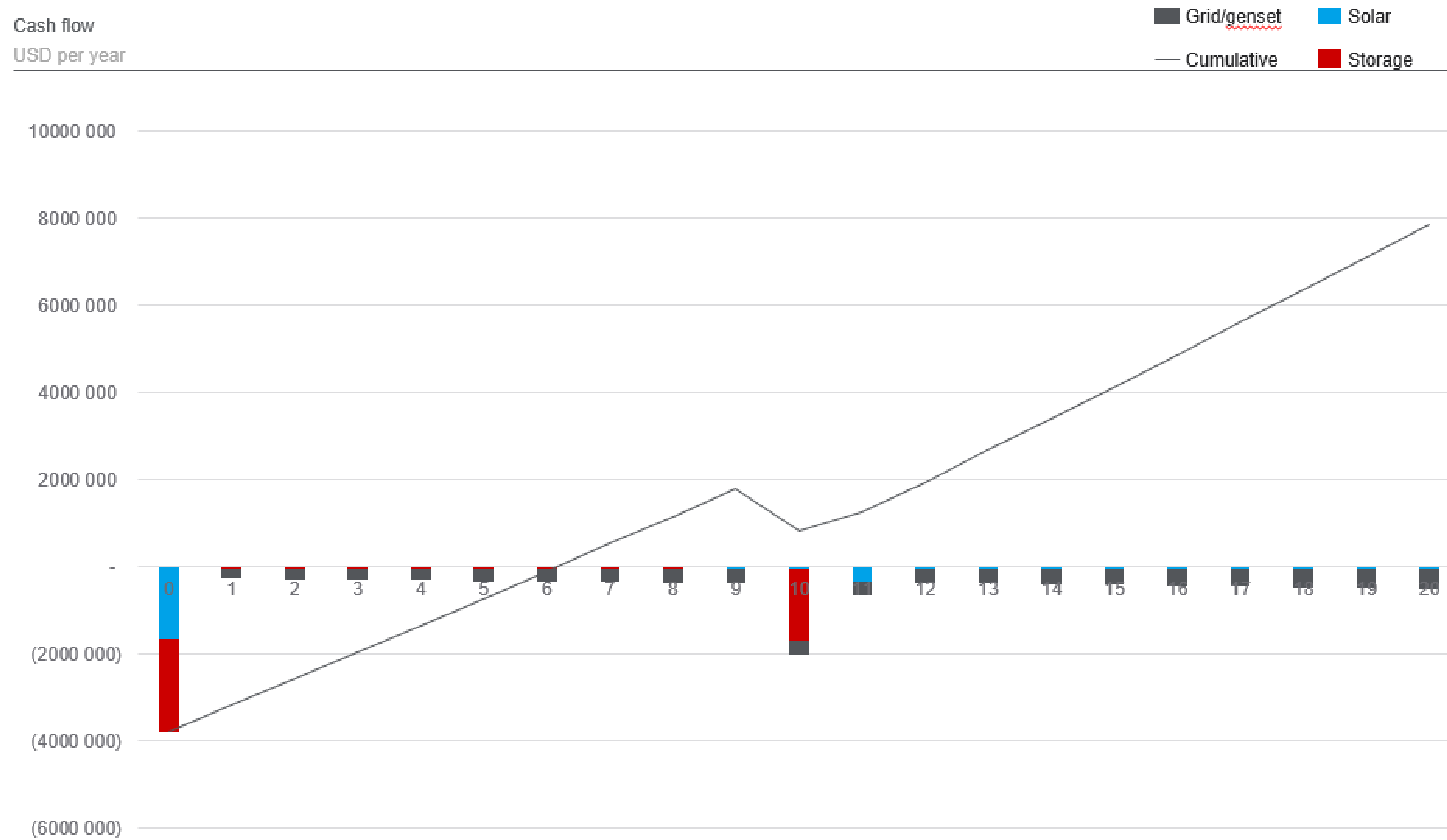


Storage charges primarily from renewables as well as from excess thermal baseload generation

Lower speed / larger fossil engines run as 'baseload' generators

Renewables limited relative to generators and storage power

BUSINESS CASE | 1.5 MW PV, 1.12 MW – 4.42 MWH STORAGE



HORNSDALE POWER RESERVE CO-LOCATED WITH 309MW WIND FARM

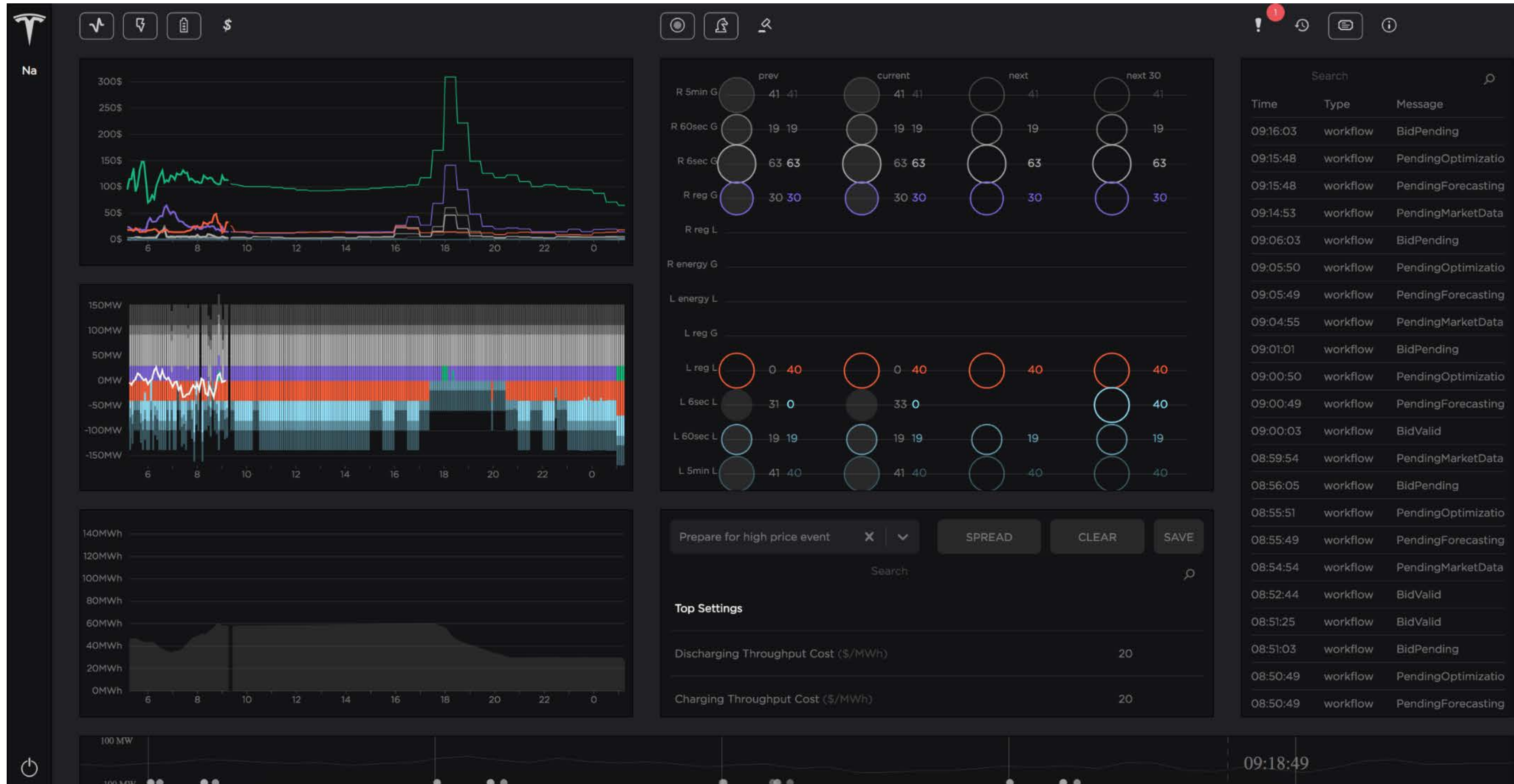


Hornsdale, South Australia

~~100 MW | 129 MWh~~
150MW | 193 MWh

~~Commissioned December 2017~~
Commissioned Q1 2020

HORNSDALE POWER RESERVE CO-LOCATED WITH 309MW WIND FARM



1. Grid Services market participation

2. Strategic Reserve

FREQUENCY REGULATION

Figure 1 Accuracy and speed of regulation FCAS response – large conventional steam turbine

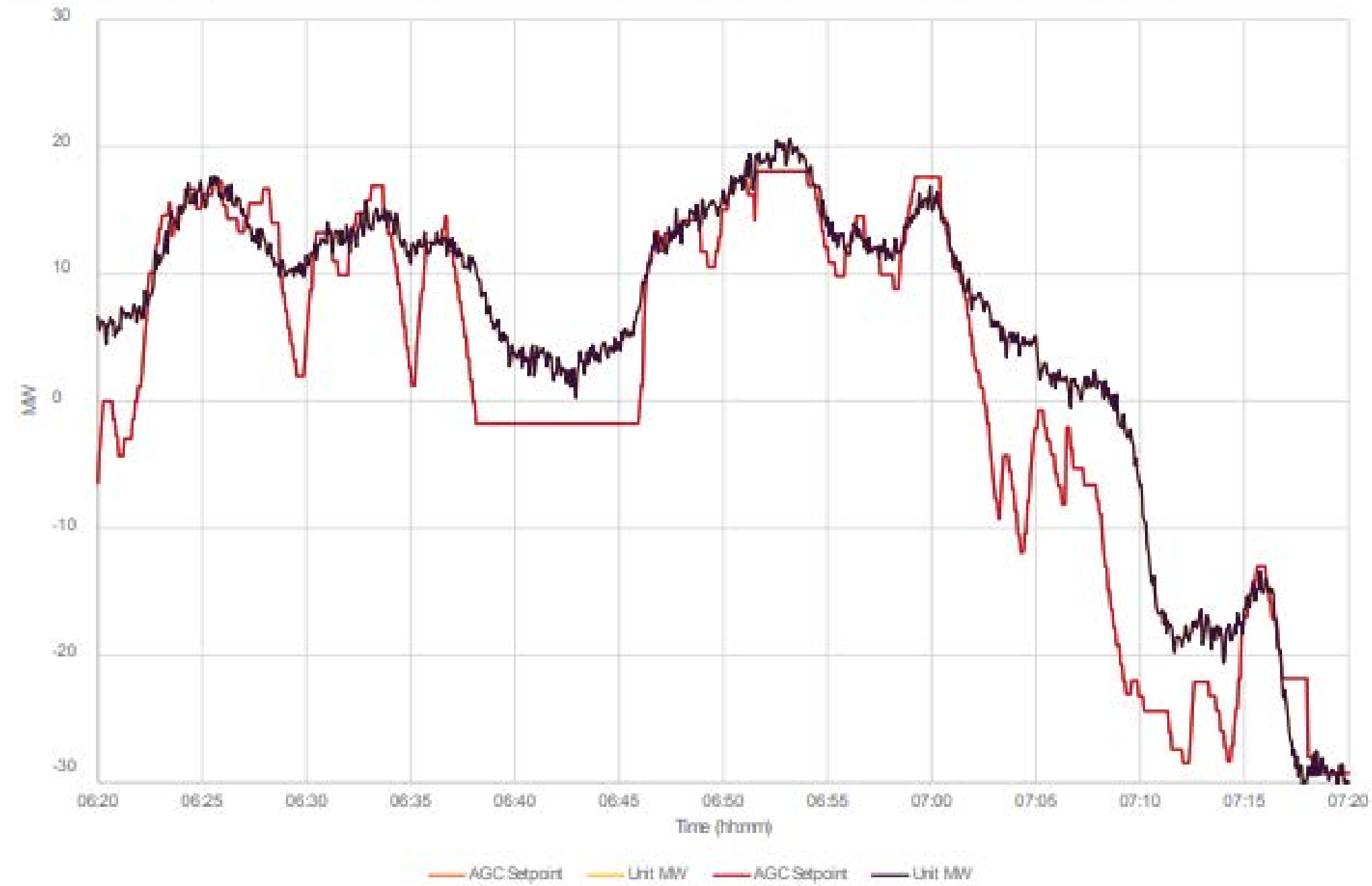
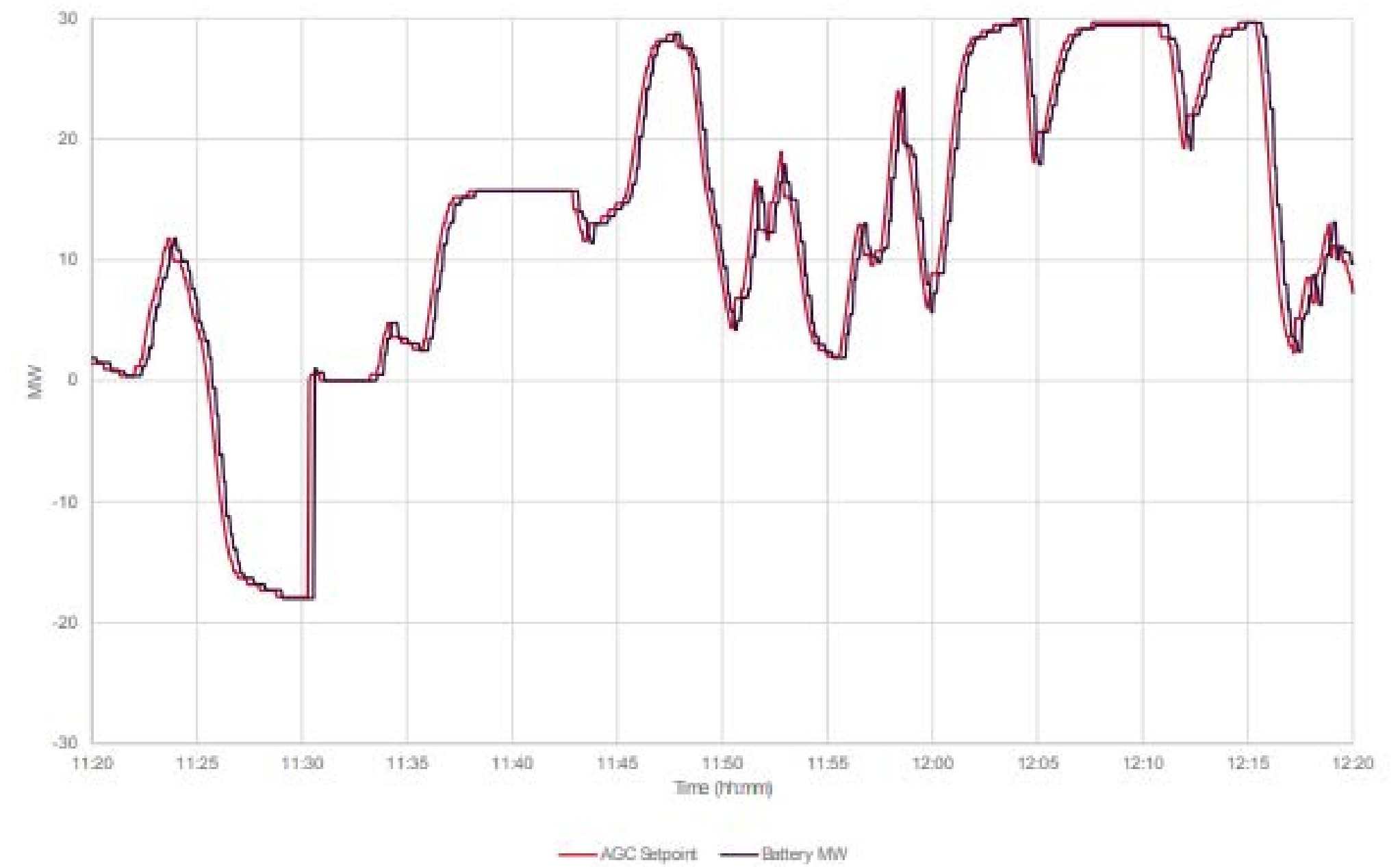


Figure 2 Accuracy and speed of regulation FCAS response – Hornsdale Power Reserve

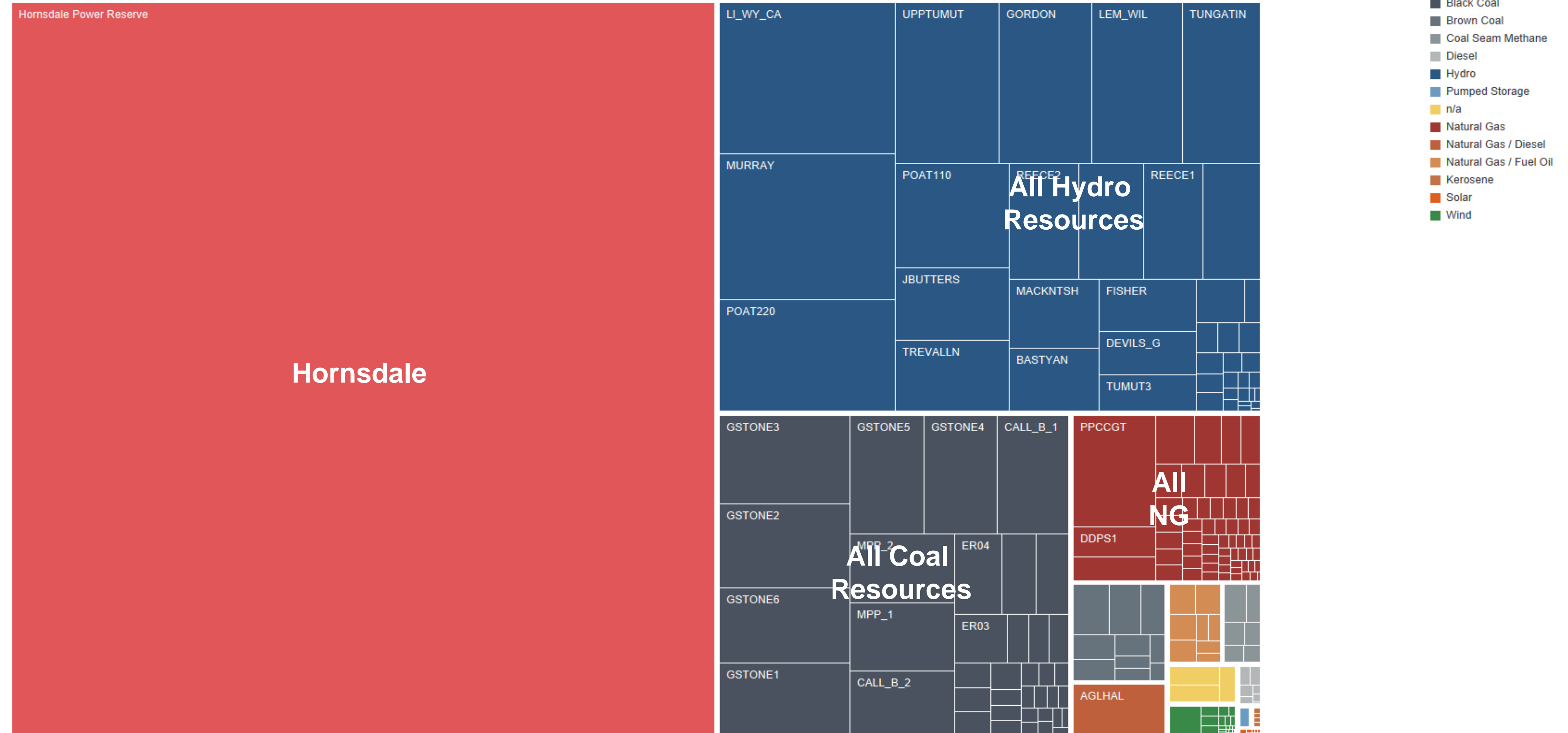


Superior accuracy and speed demonstrated by Hornsdale battery

Source: AEMO, April 2018

MARKET ACTIVITY BY RESOURCE - OPERATIONS IMPACT

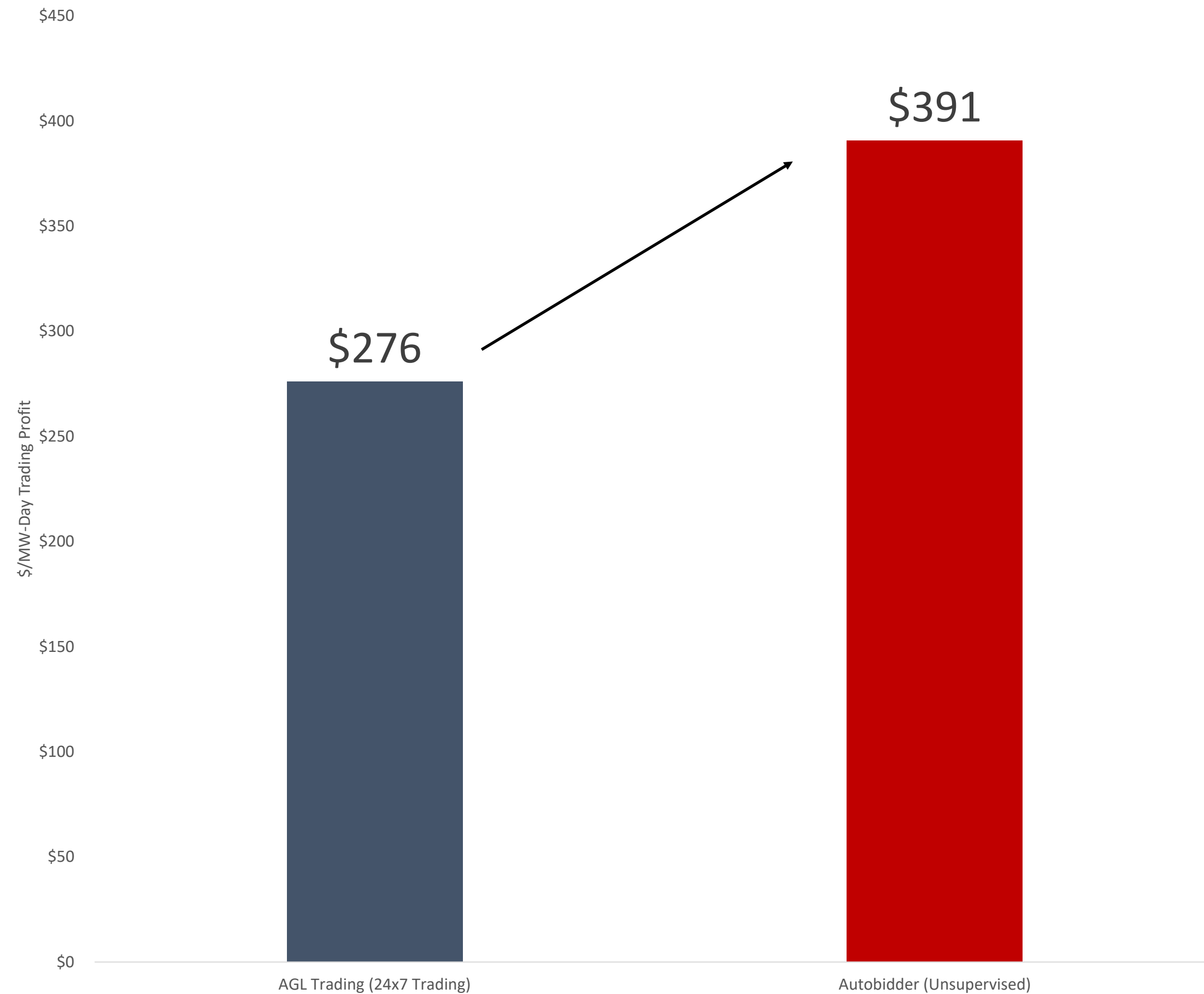
Market Activity by Resource (# of Real-Time Bids)



BENCHMARKING PERFORMANCE

Autobidder vs. AGL Trading

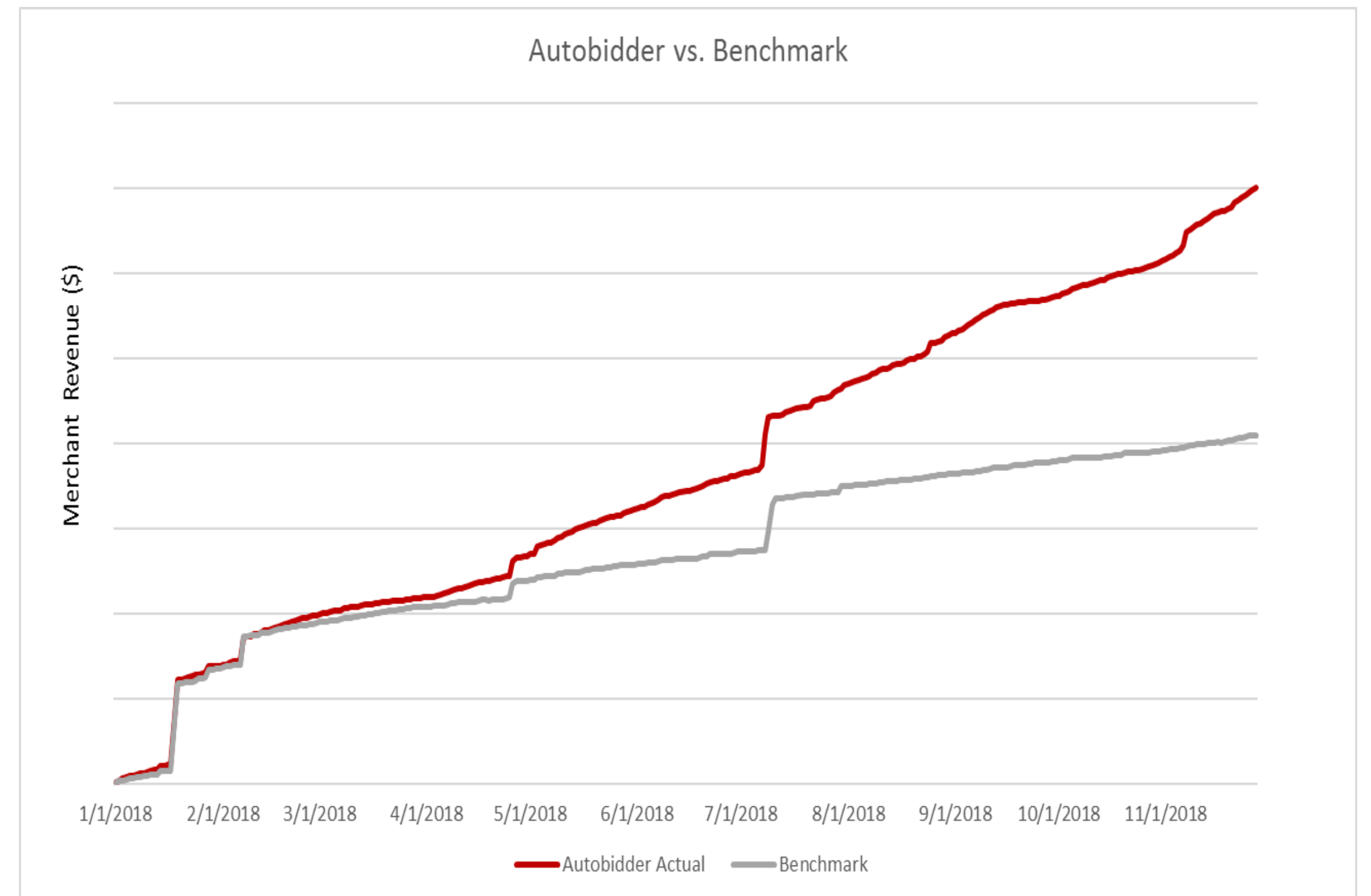
30MW/8MWh, Dec 14 – Jan 25



42% Revenue Premium on 24/7 Trading Team

Autobidder vs. Decision Tree Algorithm

Hornsdale, 2018 Benchmark Year



65% Revenue Premium versus Decision Tree Strategy

KAUAI ISLAND UTILITY COOPERATIVE (KIUC)



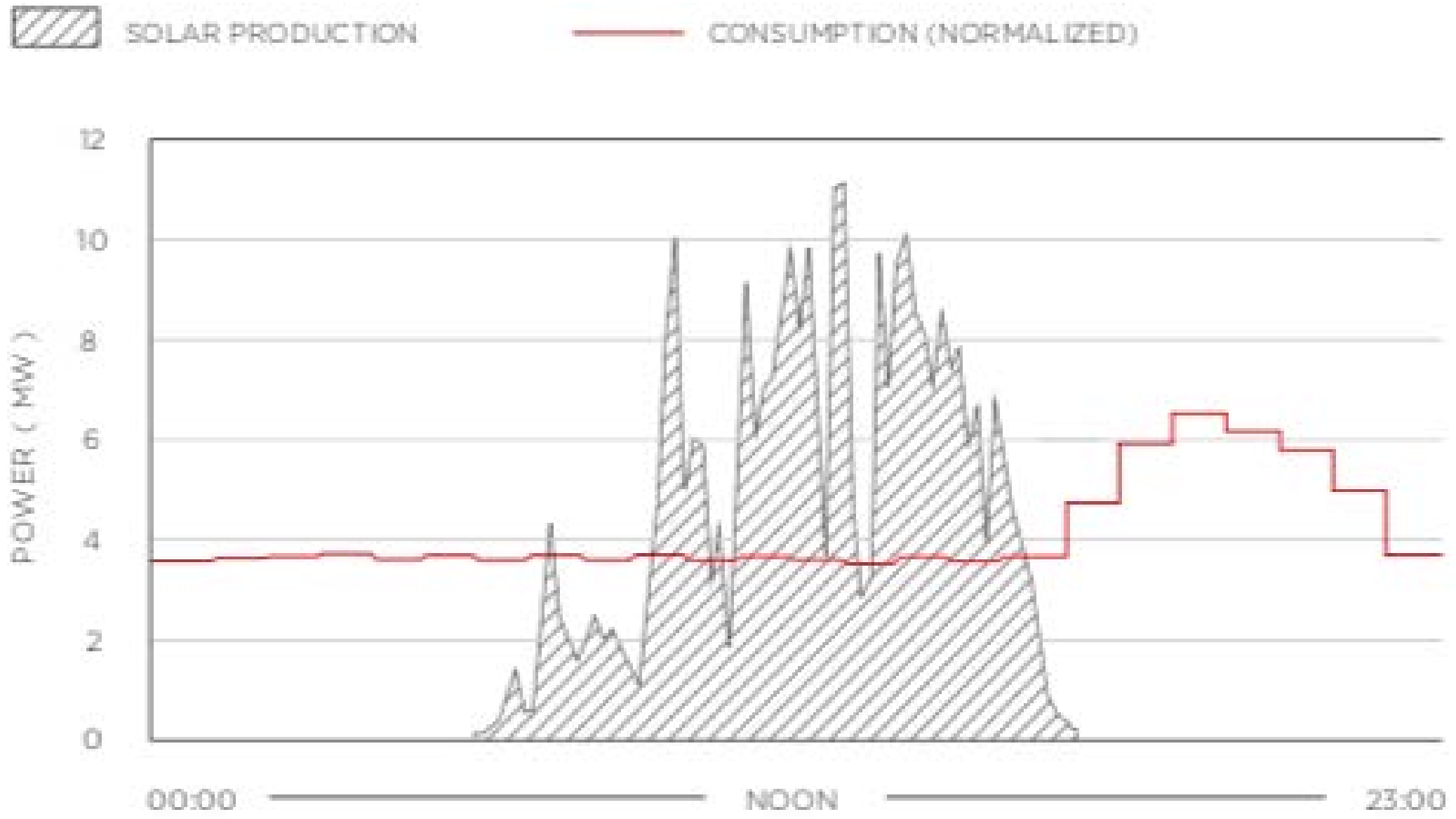
Kauai Island

13 MW | 52 MWh (13 MW Solar PV)

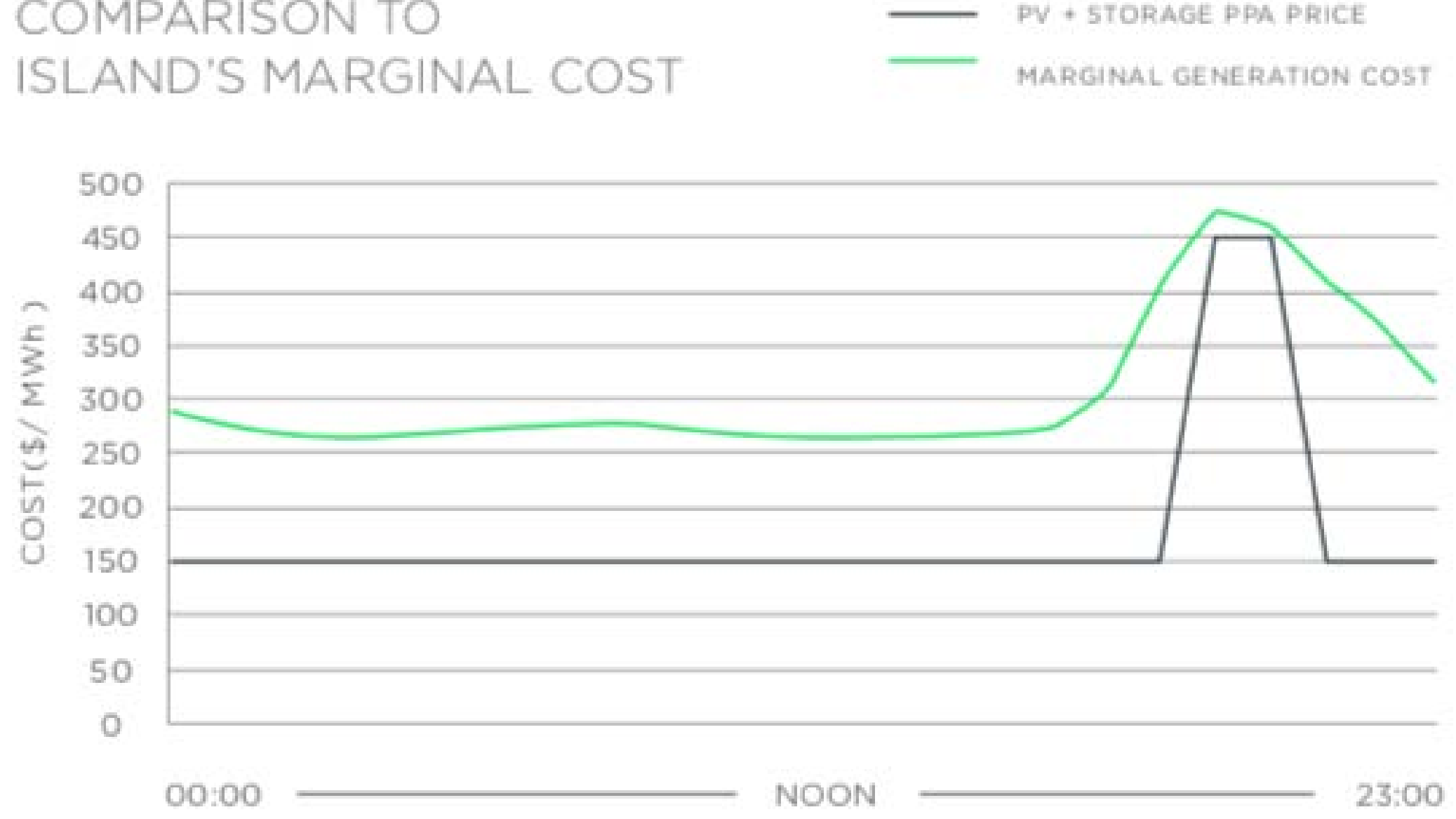
Commissioned 2017

Solar self-consumption & Load shifting

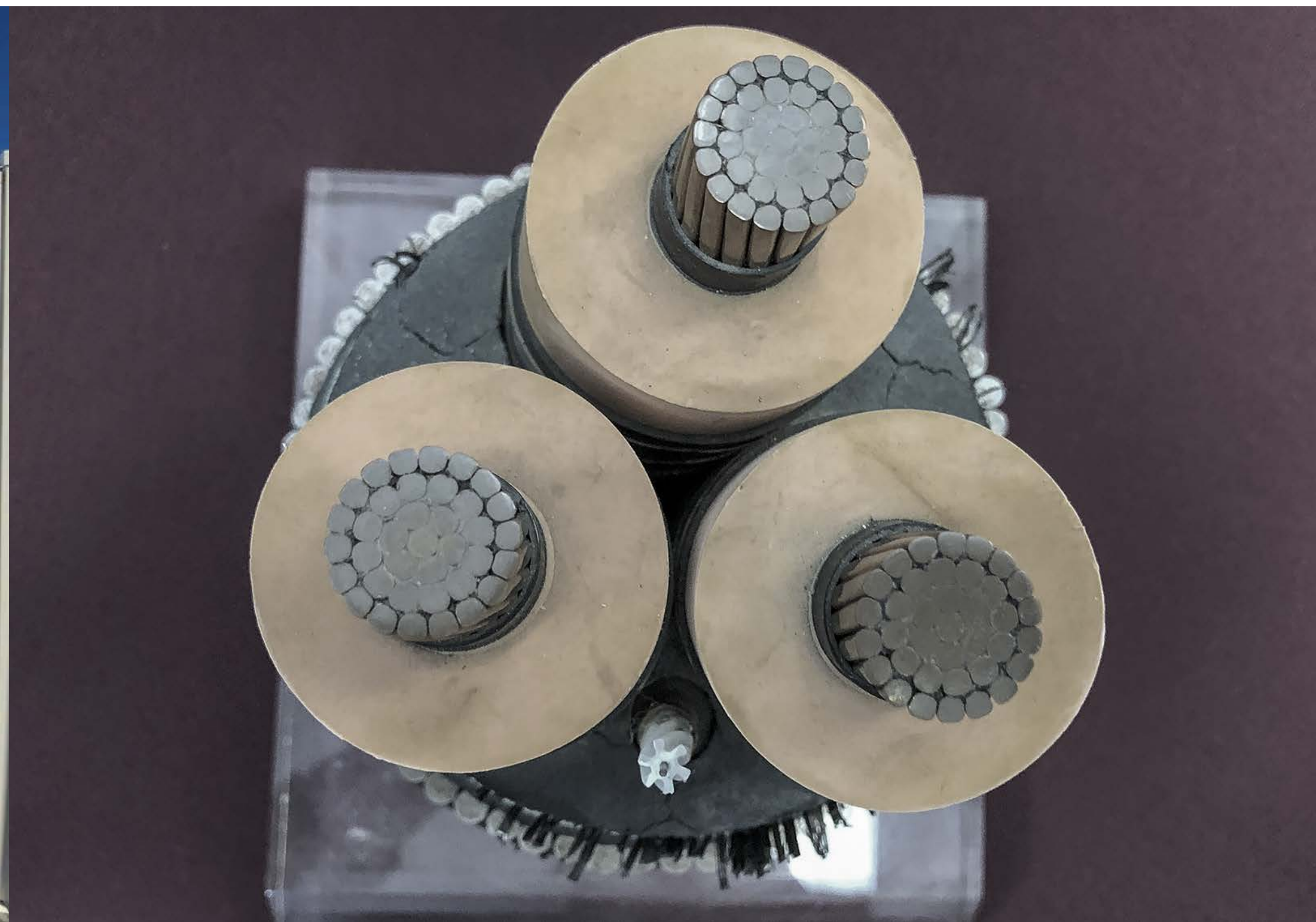
KAUAI ISLAND UTILITY COOPERATIVE (KIUC)



COMPARISON TO ISLAND'S MARGINAL COST



NANTUCKET- NEW ENGLAND



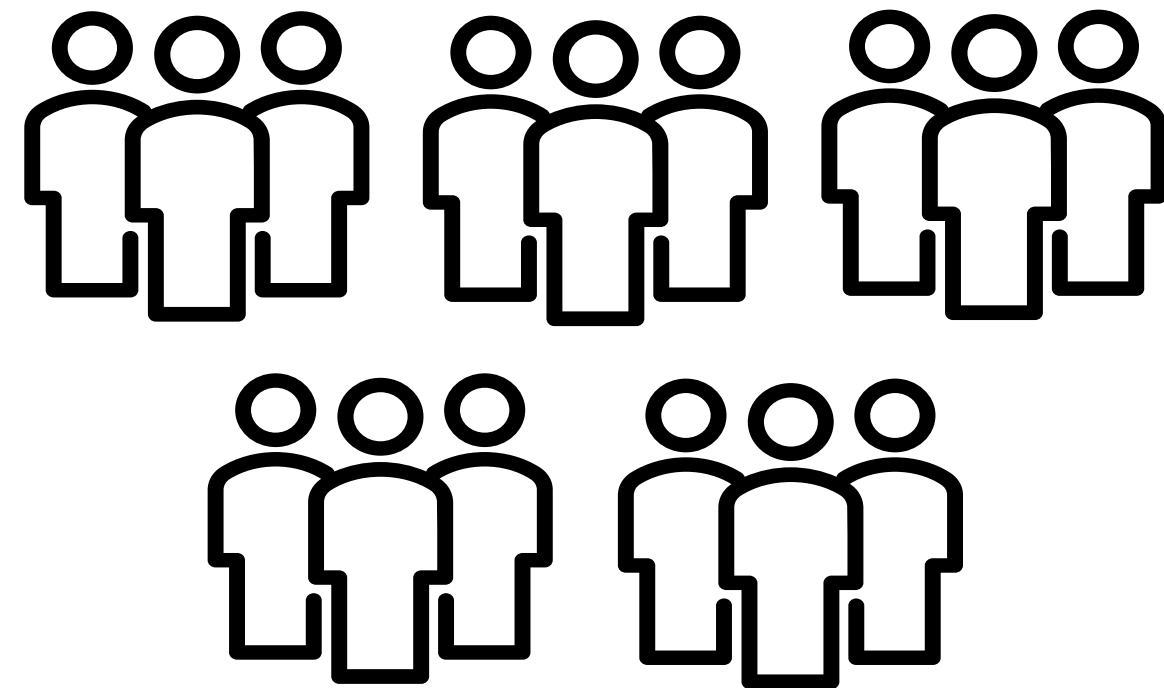
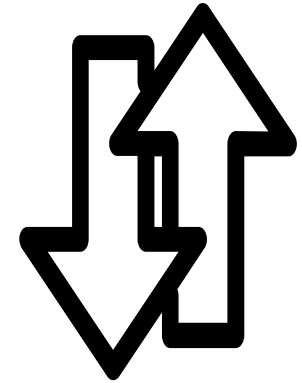
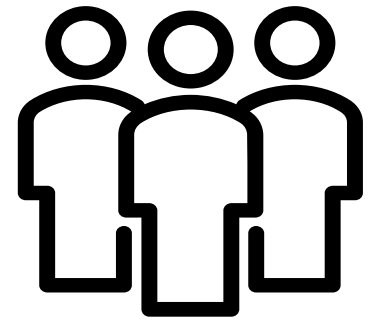
Nantucket

6 MW | 48 MWh

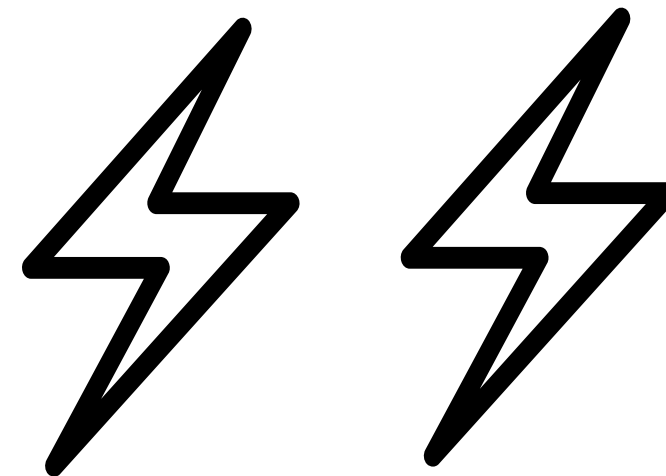
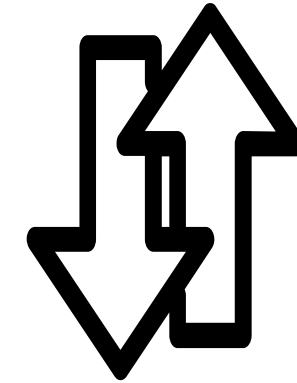
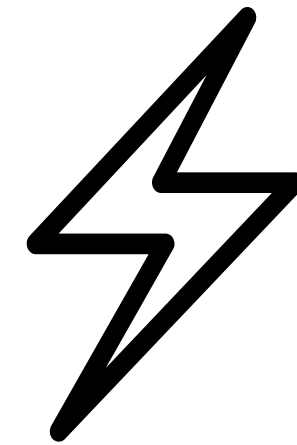
Commissioned 2019

T&D Upgrade Deferral

NANTUCKET- NEW ENGLAND

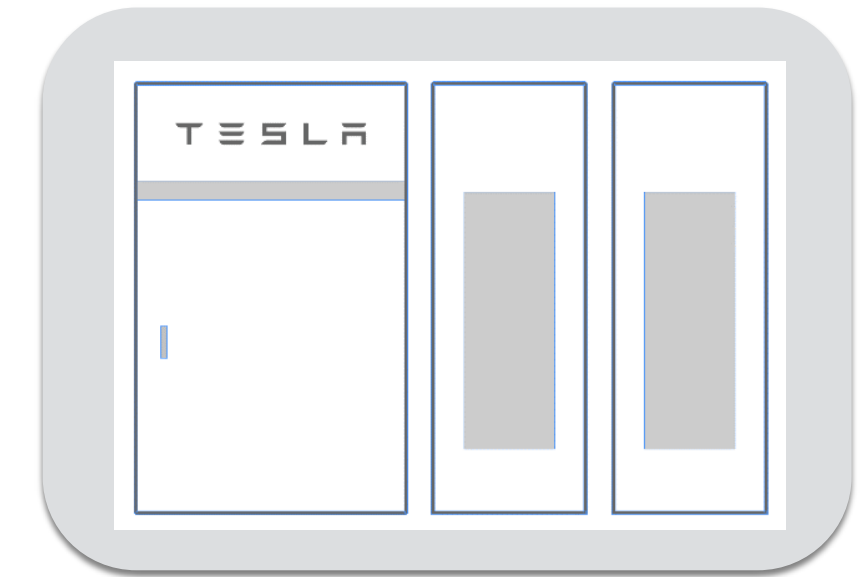
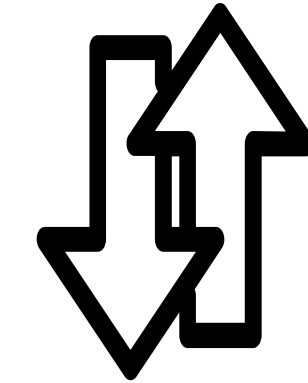


X 5 in Summer



25 MW --> 50 MW

A third subsea cable



200M USD → 81M USD

THANK YOU

