

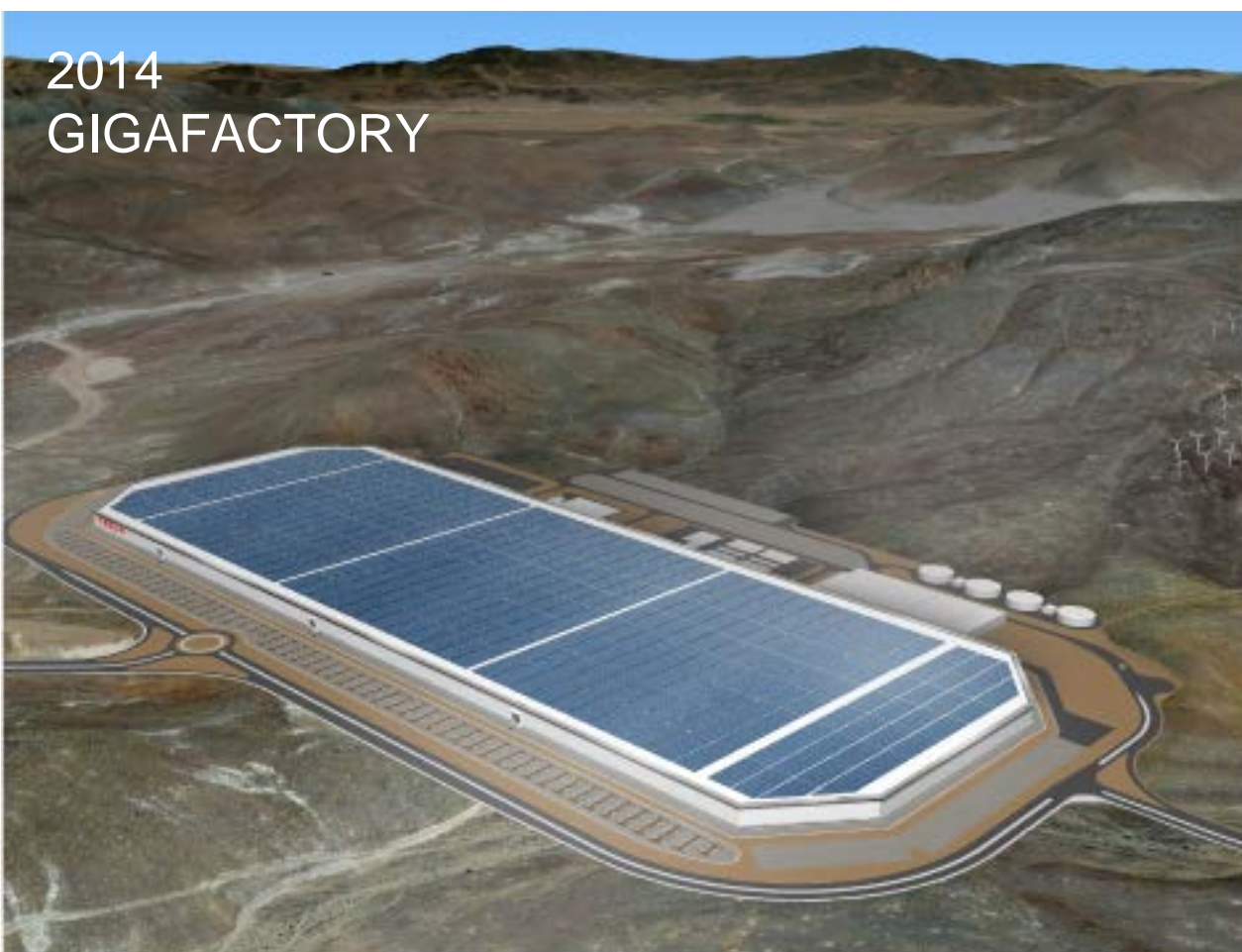
TESLA

RES West Africa| Dakar
2019, December 2nd

NOTRE MISSION

Accélérer la transition vers un schéma énergétique durable

HISTOIRE INSCRITE DANS L'INNOVATION



AMBITIONS DE TESLA



Automobile



Semi



Charge



Solaire



Powerwall



Powerpack



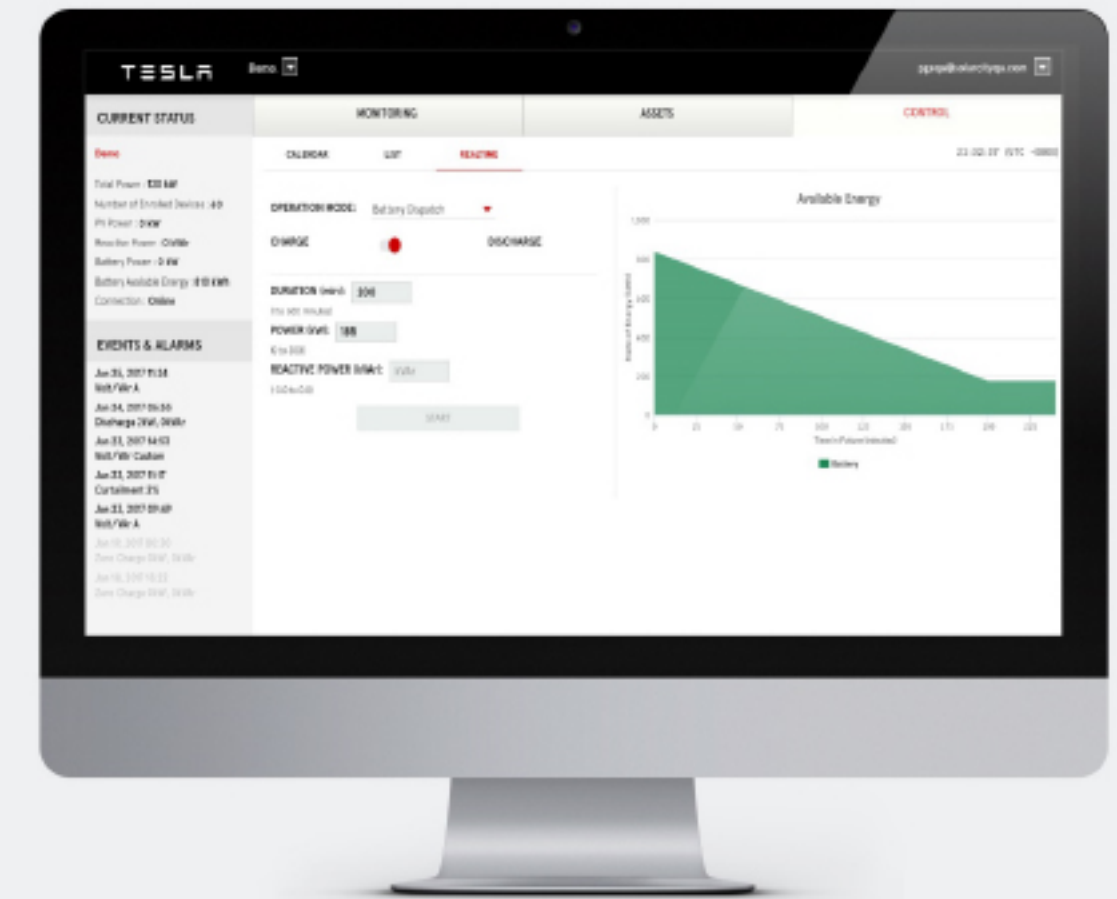
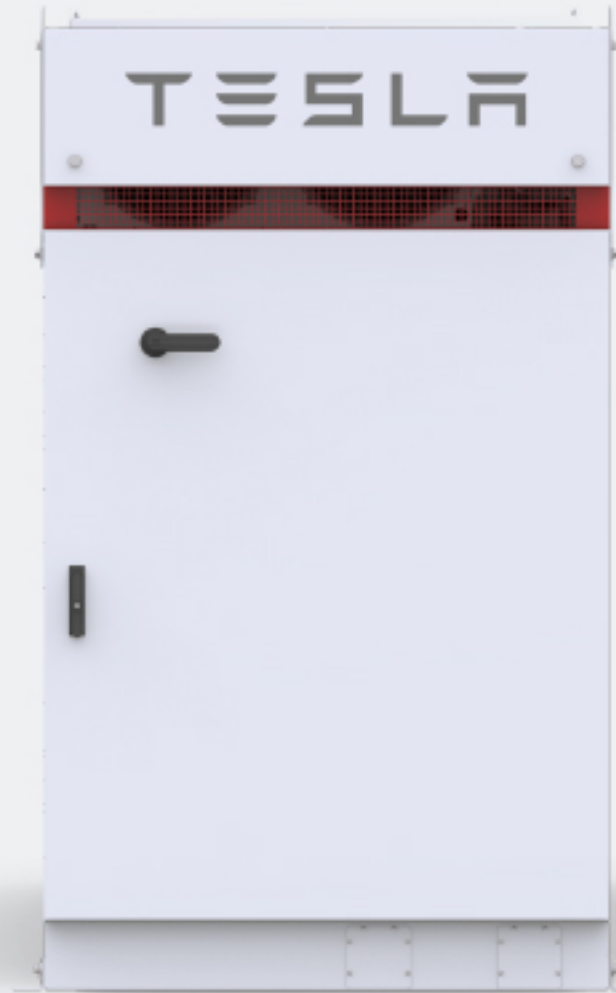
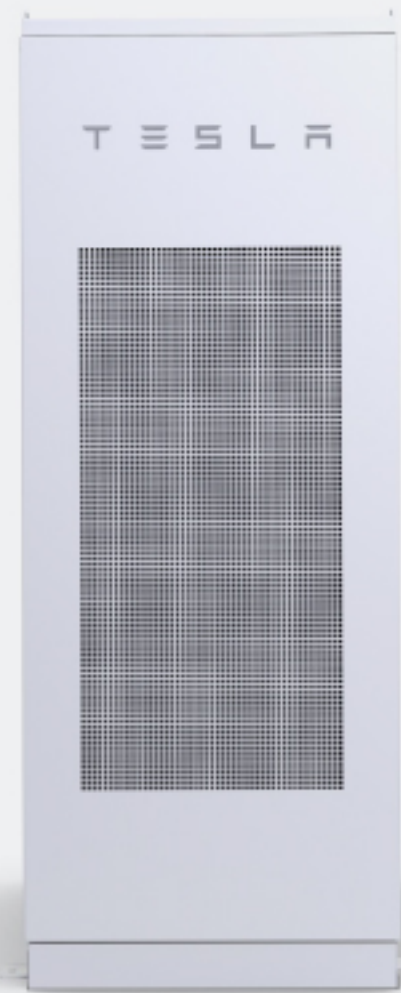
Logiciels



Megapacks

Tesla Energie

UNE SOLUTION DE STOCKAGE CLE EN MAIN



Powerpack/Megapack

BATTERIES LITHIUM-ION
REFROIDISSEMENT LIQUIDE
CONVERTISSEUR DC-DC ISOLE

Onduleur

BI-DIRECTIONNEL
MODULAIRE
CONNECTE AU RÉSEAU OU MICRO- RÉSEAU
99% EFFICACITÉ PEAK

Logiciel intégrés

OPTIMISATION
BATTERY MANAGEMENT SYSTEM
CONTRÔLEUR LOCAL

Contrôle en ligne

PILOTAGE ET SURVEILLANCE AND DIRECT
PARTICIPATION ACTIF ET RÉACTIF
OPTIMISATION DU DISPATCH ET PARTICIPATION
AU MARCHES

La contribution du stockage a travers l'ensemble des segments



Residential

Commercial

Utility

Microgrid

Residential

Commercial

Utility

Microgrid

Résidentiel

Commercial

Utility

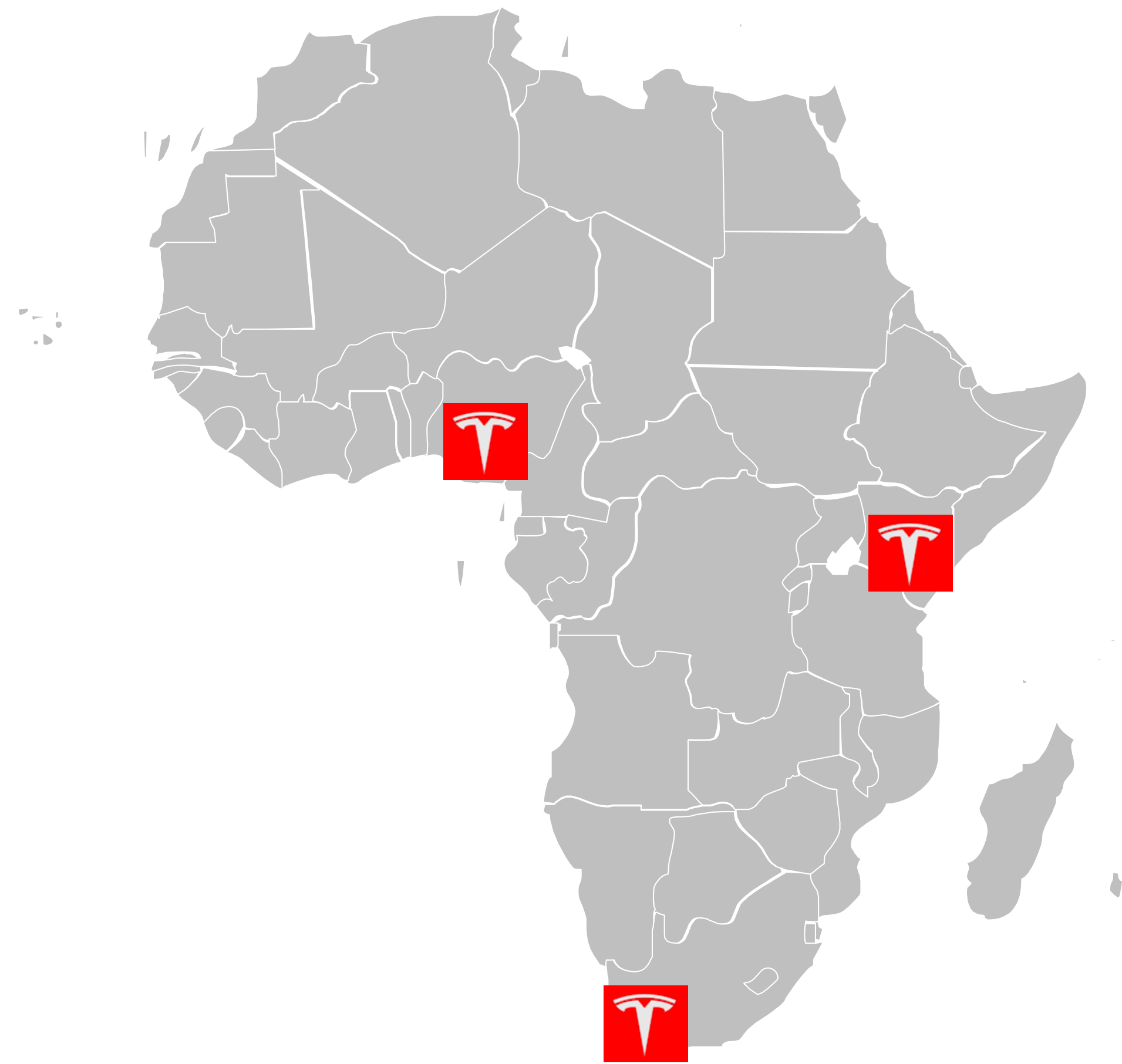
Micro-réseau

L'Afrique et Tesla

50+ systèmes contractualisés

20+ systèmes déployés

15+ pays

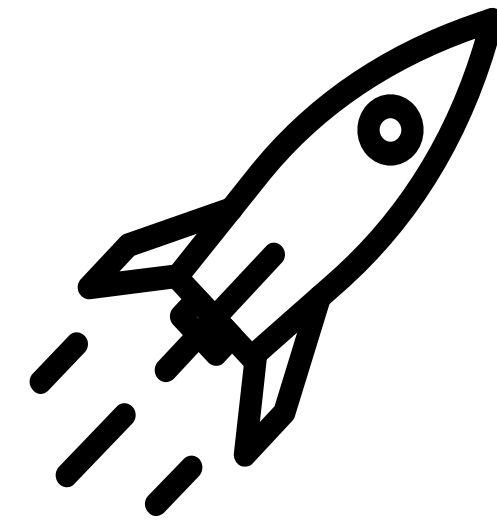
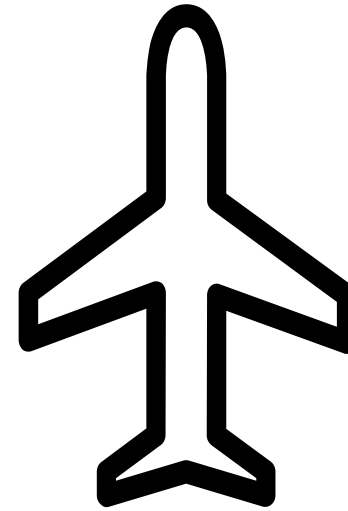
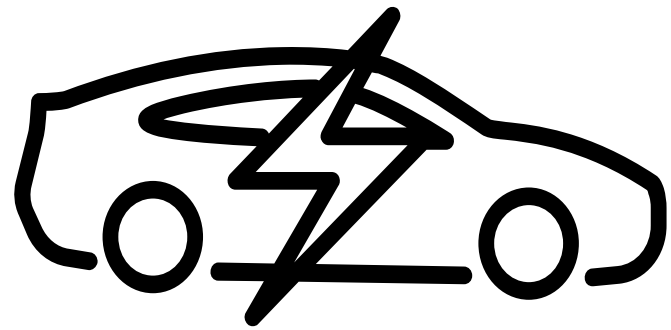


1er système déployé en mars 2017

Micro- réseau backup & économie de diesel

Réduction moyenne de la consommation de diesel de 70%

Notre approche



1 – Proof of concept <1MWh

2 – C&I 1-10MWh

3 – Utility scale >10MWh

Les micro-réseaux batteries co-localisés avec le solaire permettent de réduire drastiquement la consommation des générateurs.

Site très isolés. Ex: resort touristique ou infrastructures de santé.

Les systèmes micro-réseaux et back-up combine avec du solaire ou non permettent de réduire la consommation des générateurs.

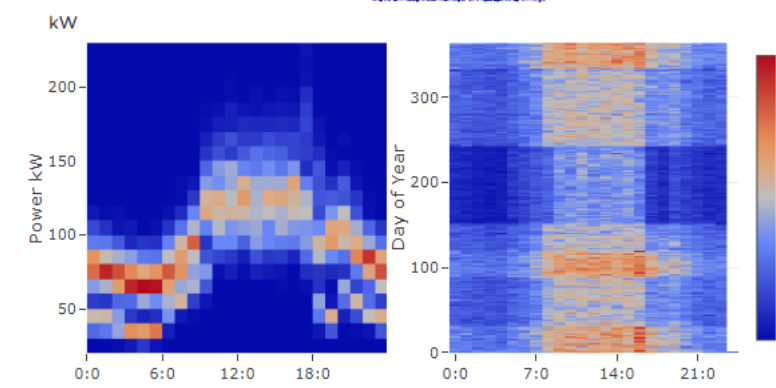
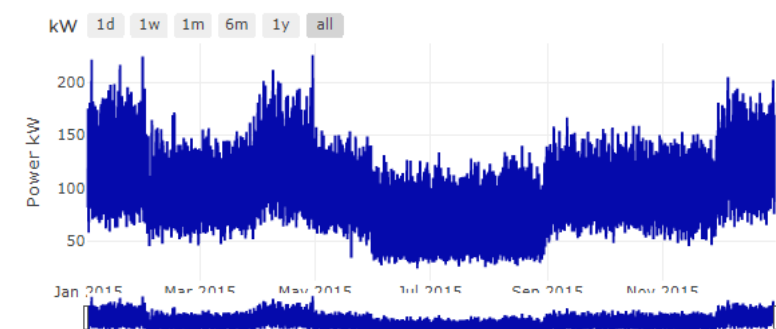
Site isolés avec un accès électrique limite et/ou non fiable. Ex: usines et électrification rurales.

Services réseaux, Optimisation des investissements réseaux, ↗ pénétration ENR et remplacement des “peakers”.

Ex: Les sous-stations clés et les projets de co-localisation avec des générations d'ampleurs.

OUTILS D'OPTIMISATION ET DIMENSIONNEMENT DES MICRO-RÉSEAUX

Inputs site et systèmes



Load Specifications
Load Escalation Rate %
Min Load Met %

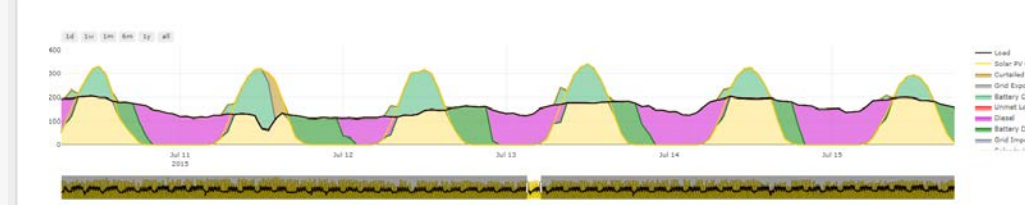
Solar PV Sweep **Single**

Generation Profile **Upload**
csv/xls/xlsx in table or list format.

or drag file(s)

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

Simulation du dispatch

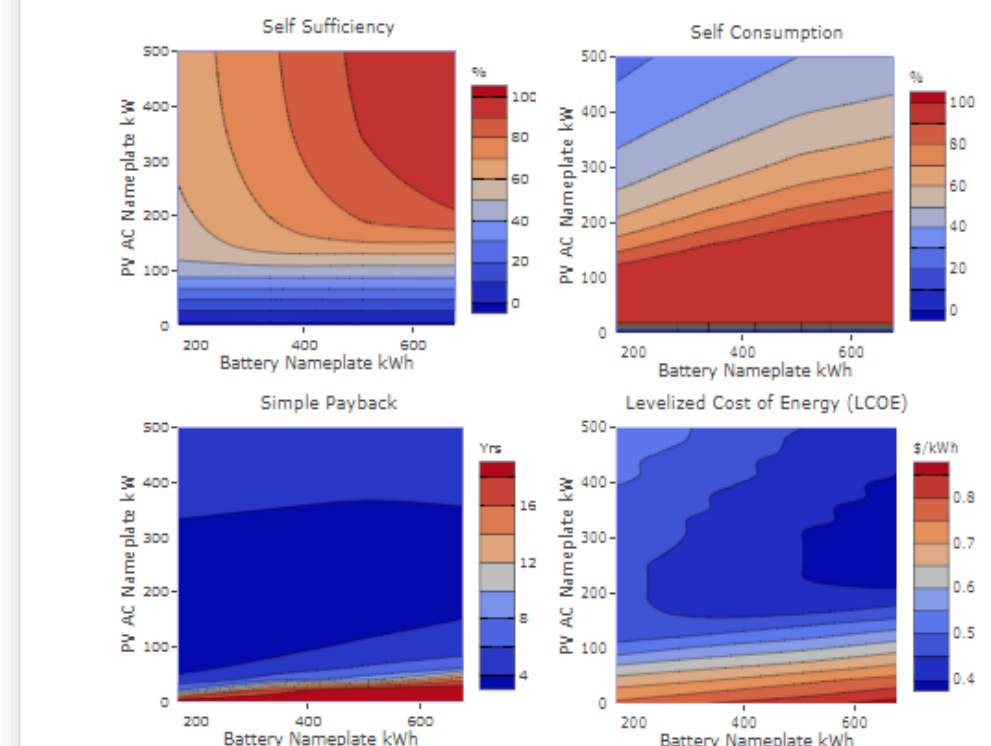


interval_data_400_528_845_250.csv - Excel

	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 Di	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	19
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.

Definition des optimales

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%



Analyse économique

dashboard

INPUTS

Diesel

Grid
Interconnection Size \$ 0
Cost \$ -
Utility bill Annual charge \$ -

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	\$/kW
Storage	\$ 442,320	442,320
Solar	\$ 206,209	396,209
Genset	\$ 150,000	90,000
Grid	\$ -	-
Total	\$ 798,529	978,529

LCOE

	\$/USD	\$/kW
Grid	\$ -	-
Solar PV-produced	\$ 0.094	0.094
Solar PV-unused	\$ 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	\$/kW
Total-construction	\$ 20,000	20,000
Microgrid-controller	\$ 50,000	50,000
EPC	\$ 6,000	6,000
Step-up-transformer	\$ 50,000	50,000
Shoring	\$ 4,000	6,000
Envirole	\$ 295,000	295,000

Run hours

		Genset only	Genset + solar	Renewables only
January	Avg	8.93	4.94	11.03
February	Avg	8.90	6.12	8.36
March	Avg	9.77	7.74	5.48
April	Avg	14.43	7.90	4.67
May	Avg	12.74	6.19	3.16
June	Avg	13.63	7.93	2.23
July	Avg	13.77	8.00	2.23
August	Avg	11.68	7.87	4.48
September	Avg	11.07	8.93	4.00
October	Avg	9.42	6.71	7.87
November	Avg	9.10	5.07	9.83
December	Avg	8.57	1.50	9.93

TOURISME DURABLE: GREAT PLAINS MPALA JENA, ZIMBABABWE



Micro-réseau

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

Mise en service 2018

Safari lodge est alimenté par une énergie silencieuse, fiable et renouvelable avec une réduction de l'usage du diesel par ~90%

ENERGISÉ DES CENTRES DE SANTE ISOLES: BORNO STATE, NIGERIA



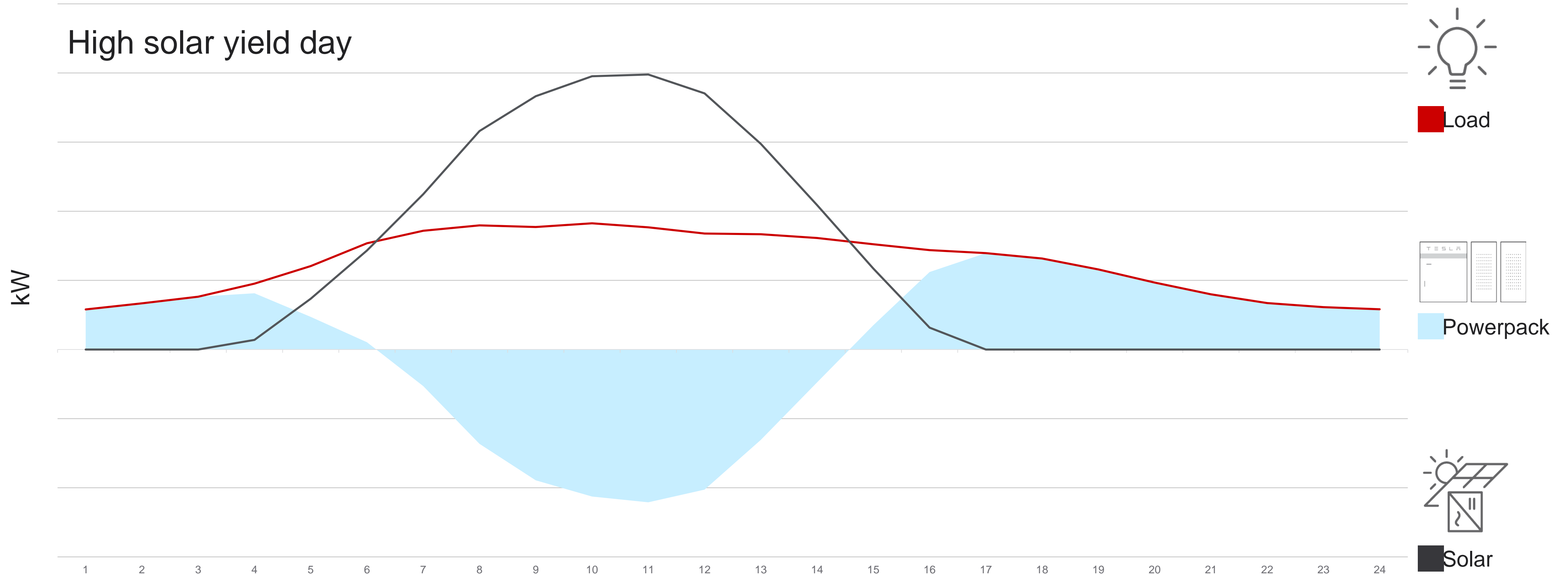
6 x Micro-réseaux

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

Mise en service 2018/2019

Une énergie renouvelable, fiabilité et économique pour des centres de sante dans le Nord du Nigeria.

RENEWABLES ONLY: GRID-FORMING POWERPACK ENABLES HIGH RENEWABLES PENETRATION



Storage charges exclusively from renewables on days with typical solar production

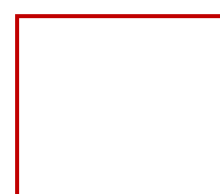
Fossil fuel generators shut down completely while renewables power batteries and load

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

ELECTRIFICATION RURALES: AREZA AND MAIDMA, ERITREA



2 x Micro-réseaux

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

Mise en service 2018

De l'énergie solaire et fiable pour 2 villages qui totalisent 40 000 personnes

PLANTATION ET USINE DE THE: KISUMU, KENYA



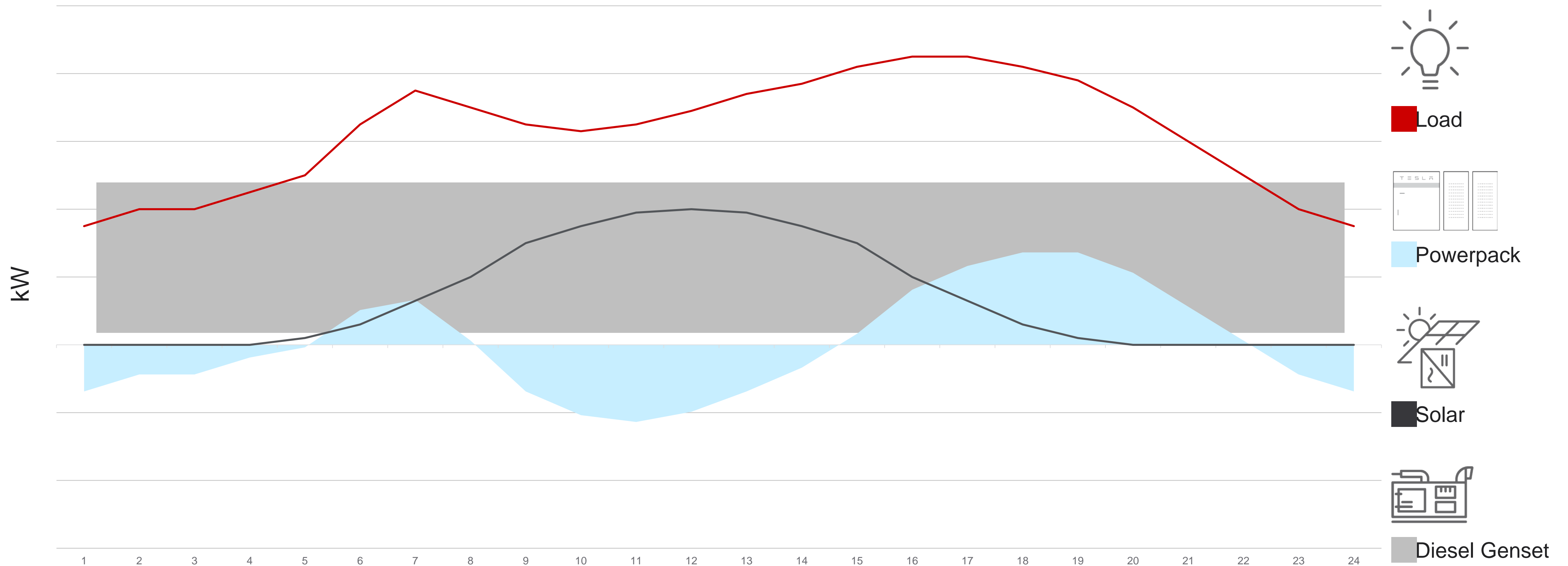
Off-grid connecte au réseau

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

Mise en service T1 2020

Energisé un site industriel qui se situe au bout du réseau.

INTERMITTENCY MANAGEMENT: POWERPACK INTELLIGENTLY BALANCES THERMAL BASELOAD AND RENEWABLES

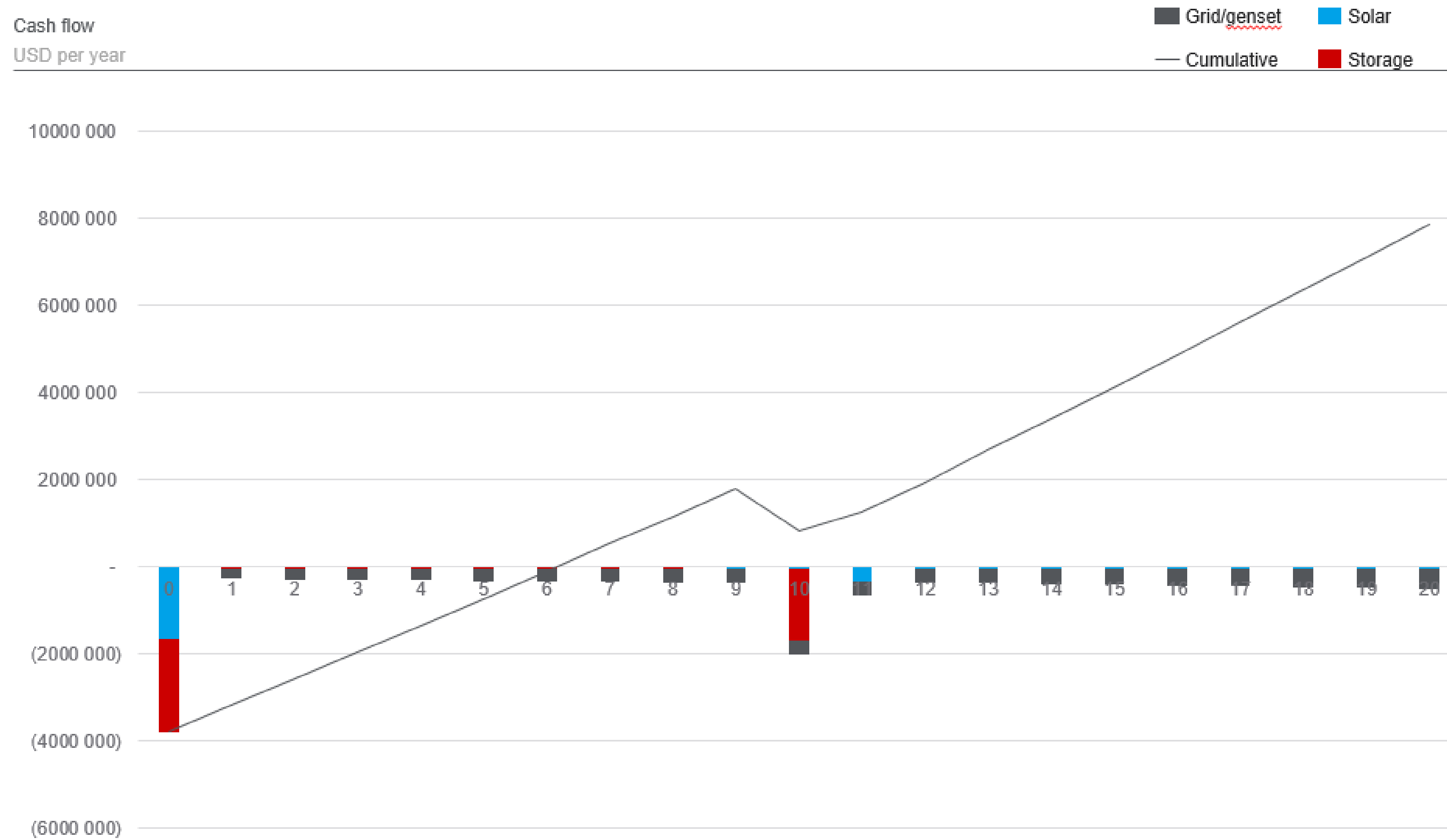


Storage charges primarily from renewables as well as from excess thermal baseload generation

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

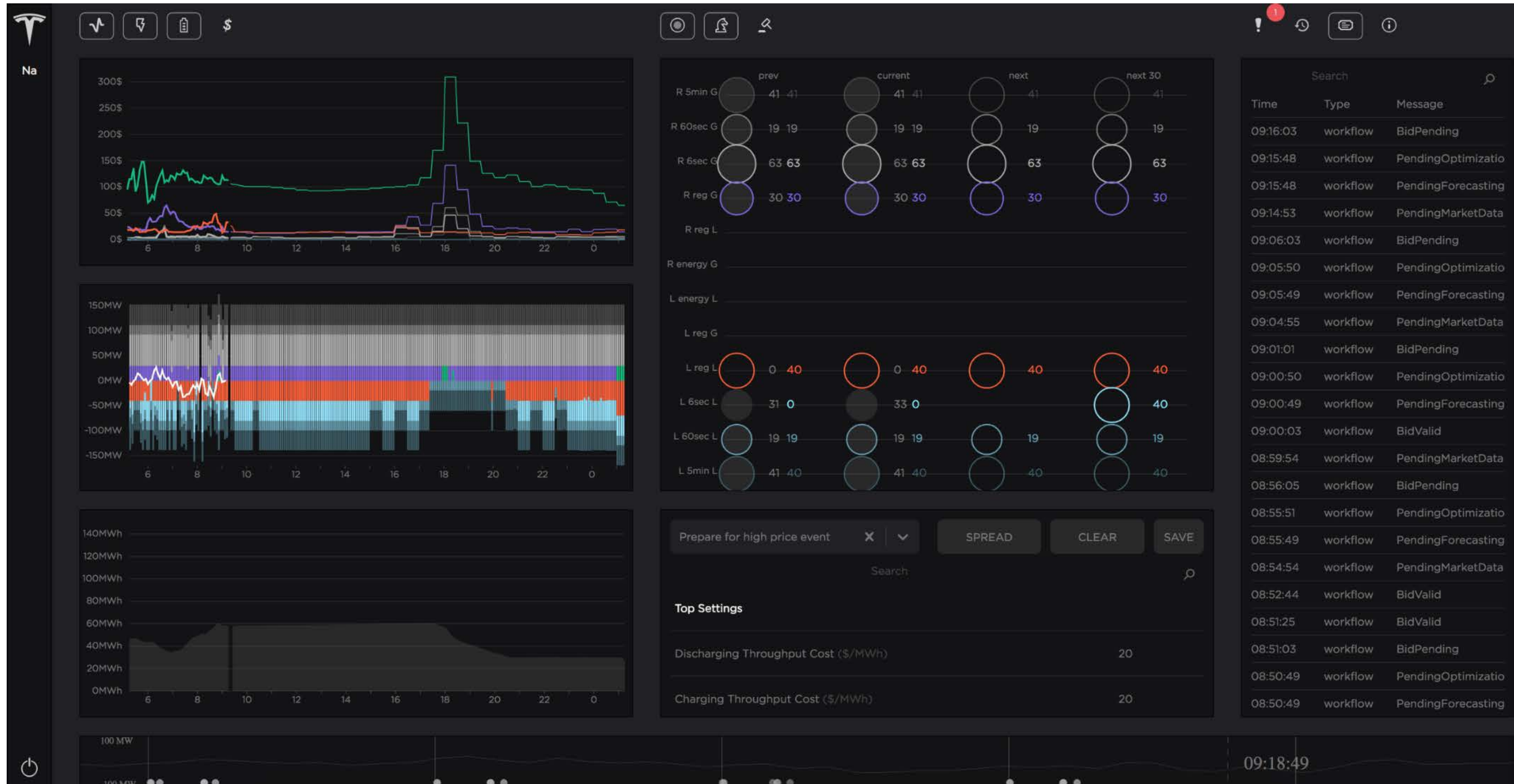


Hornsedale, South Australia

~~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

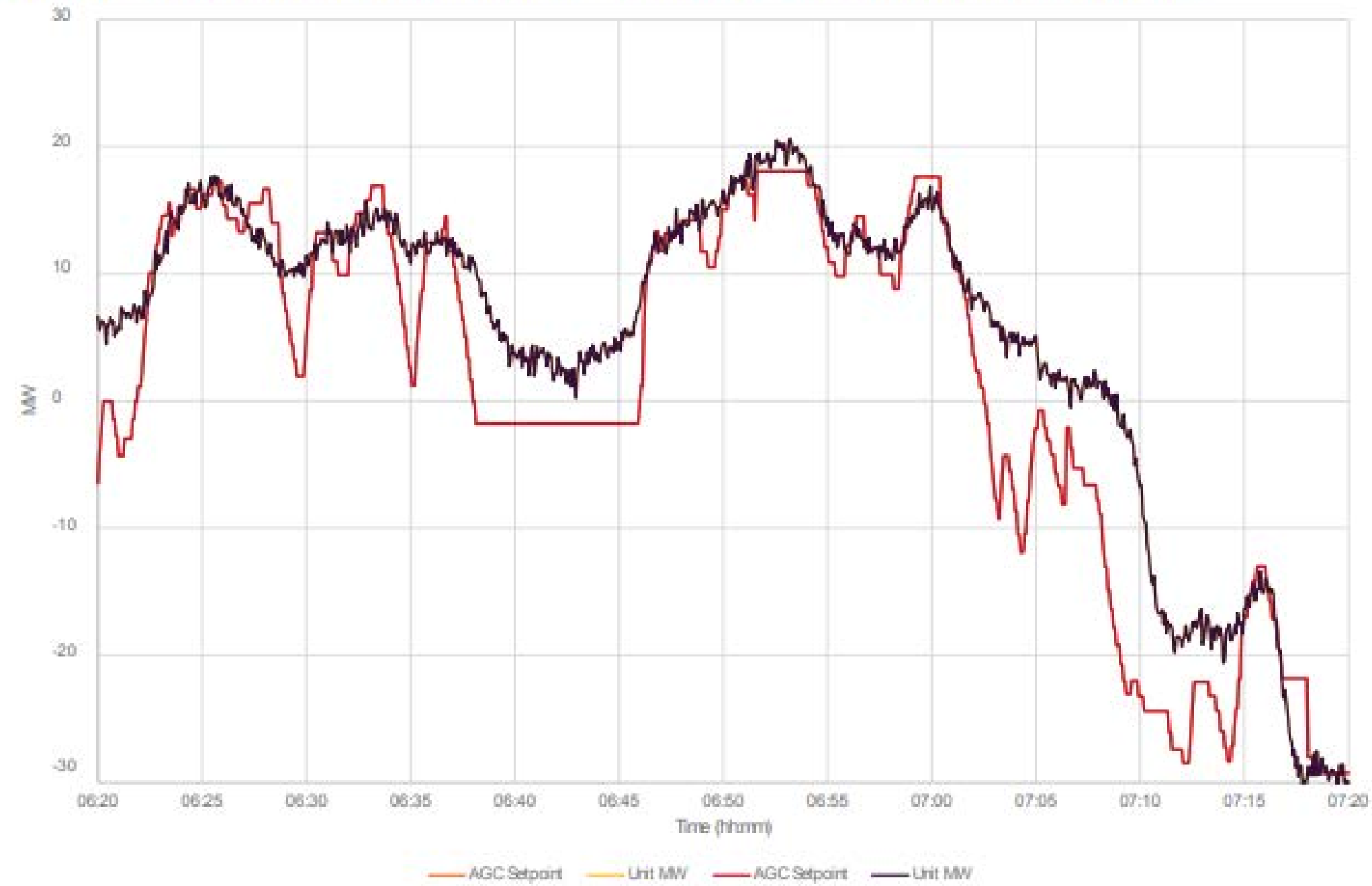
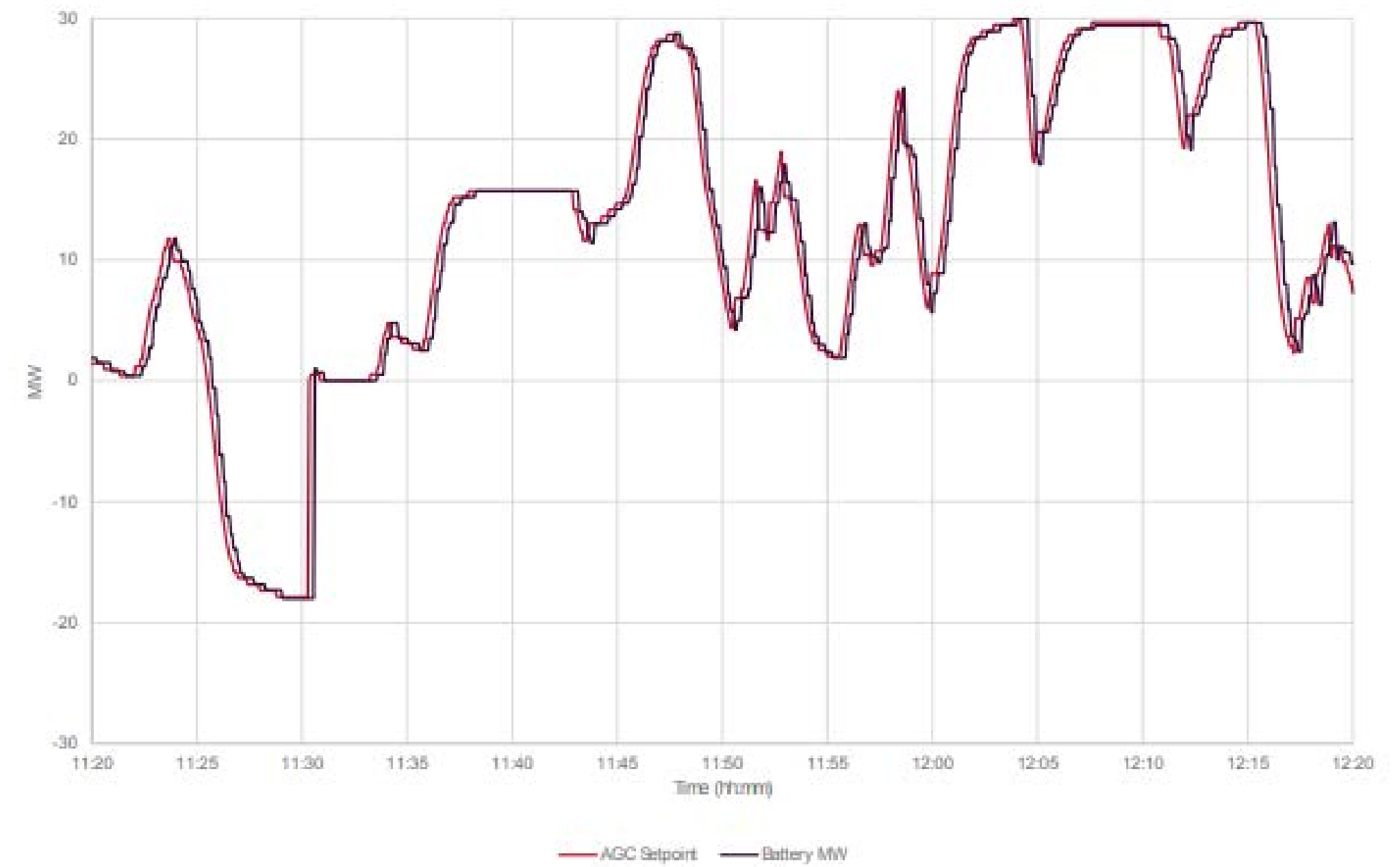


Figure 2 Accuracy and speed of regulation FCAS response – Hornsdale Power Reserve

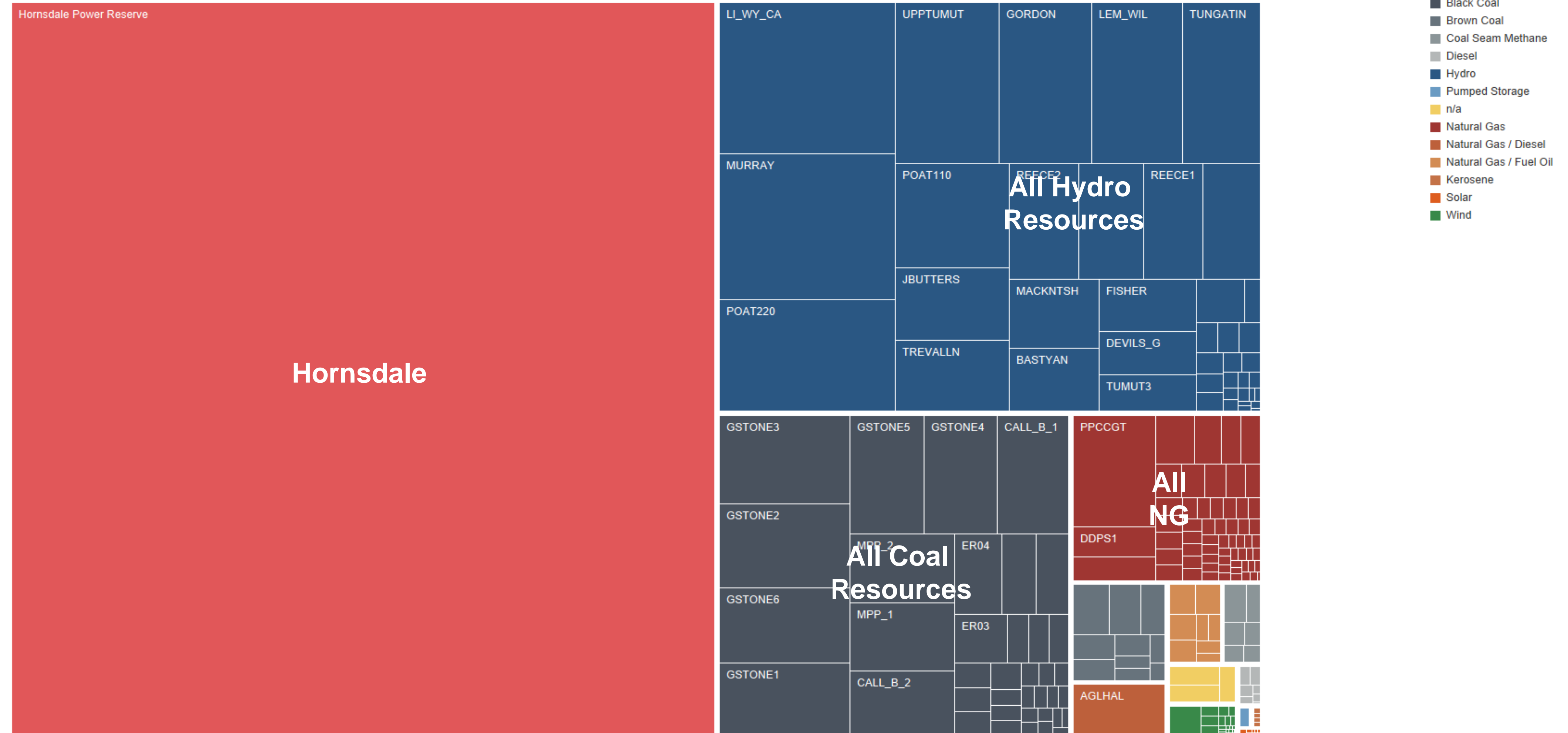


Superior accuracy and speed demonstrated by Hornsdale battery

Source: AEMO, April 2018

MARKET ACTIVITY BY RESOURCE - OPERATIONS IMPACT

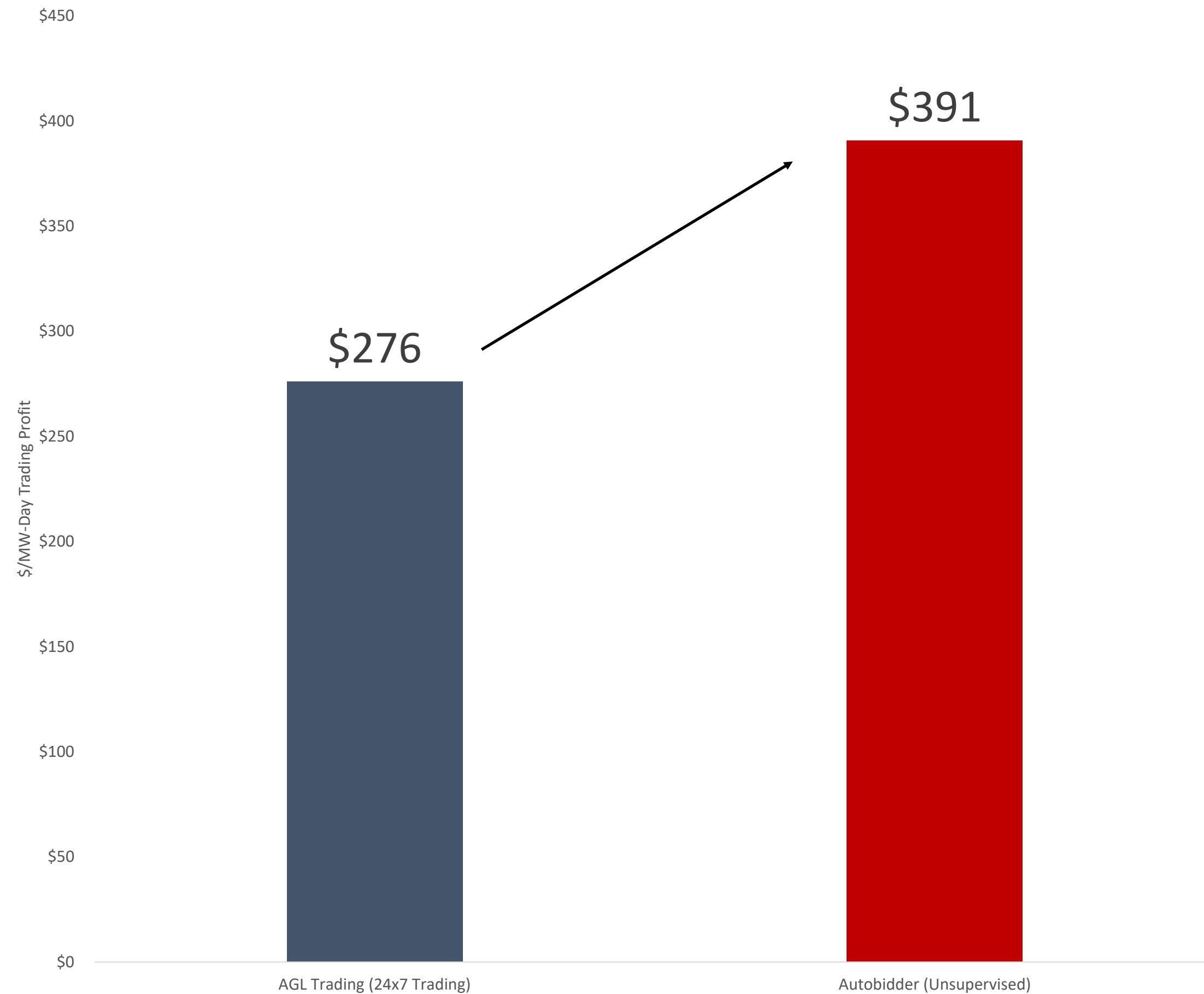
Market Activity by Resource (# of Real-Time Bids)



BENCHMARKING PERFORMANCE

Autobidder vs. AGL Trading

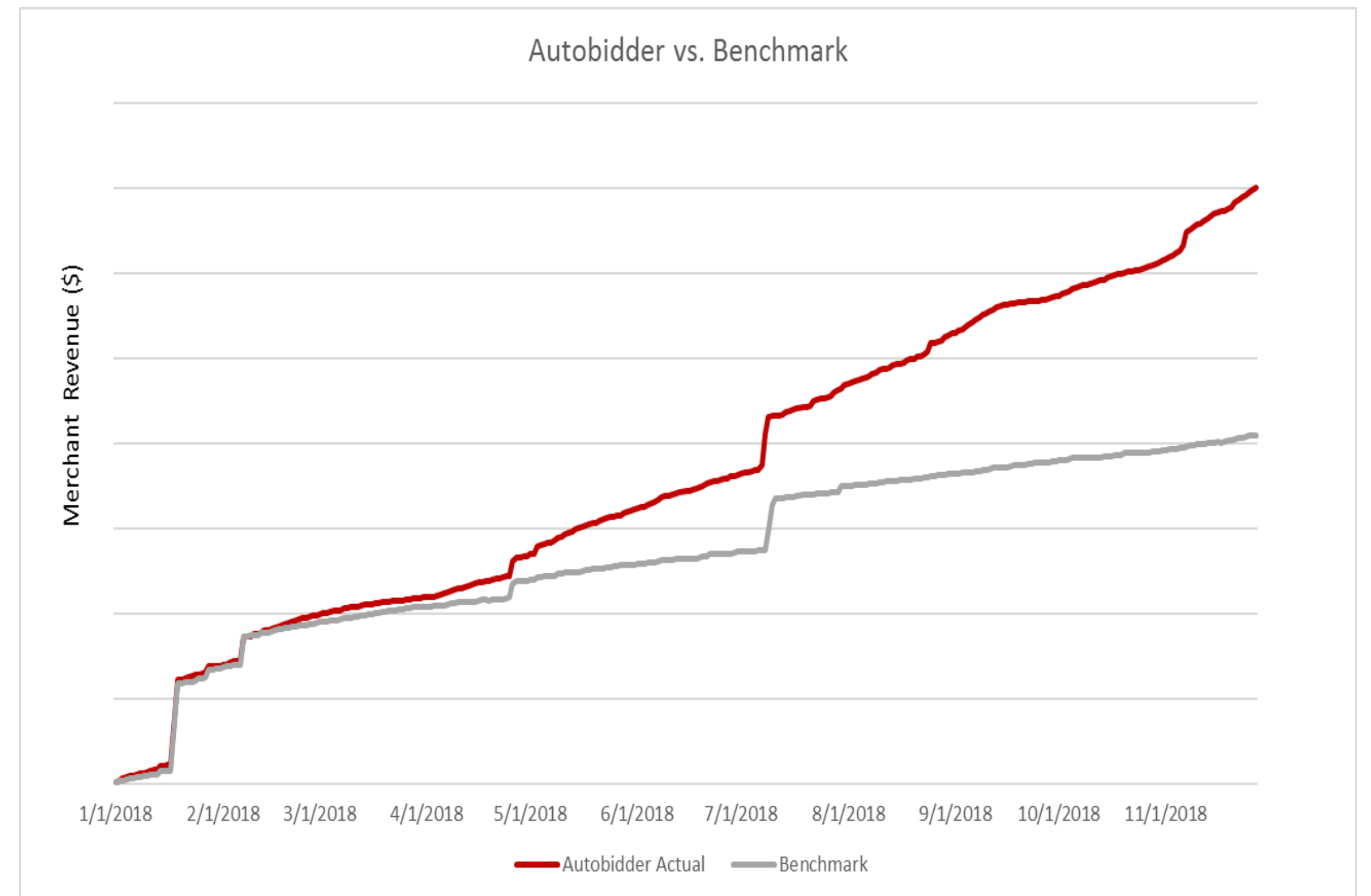
30MW/8MWh, Dec 14 – Jan 25



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)



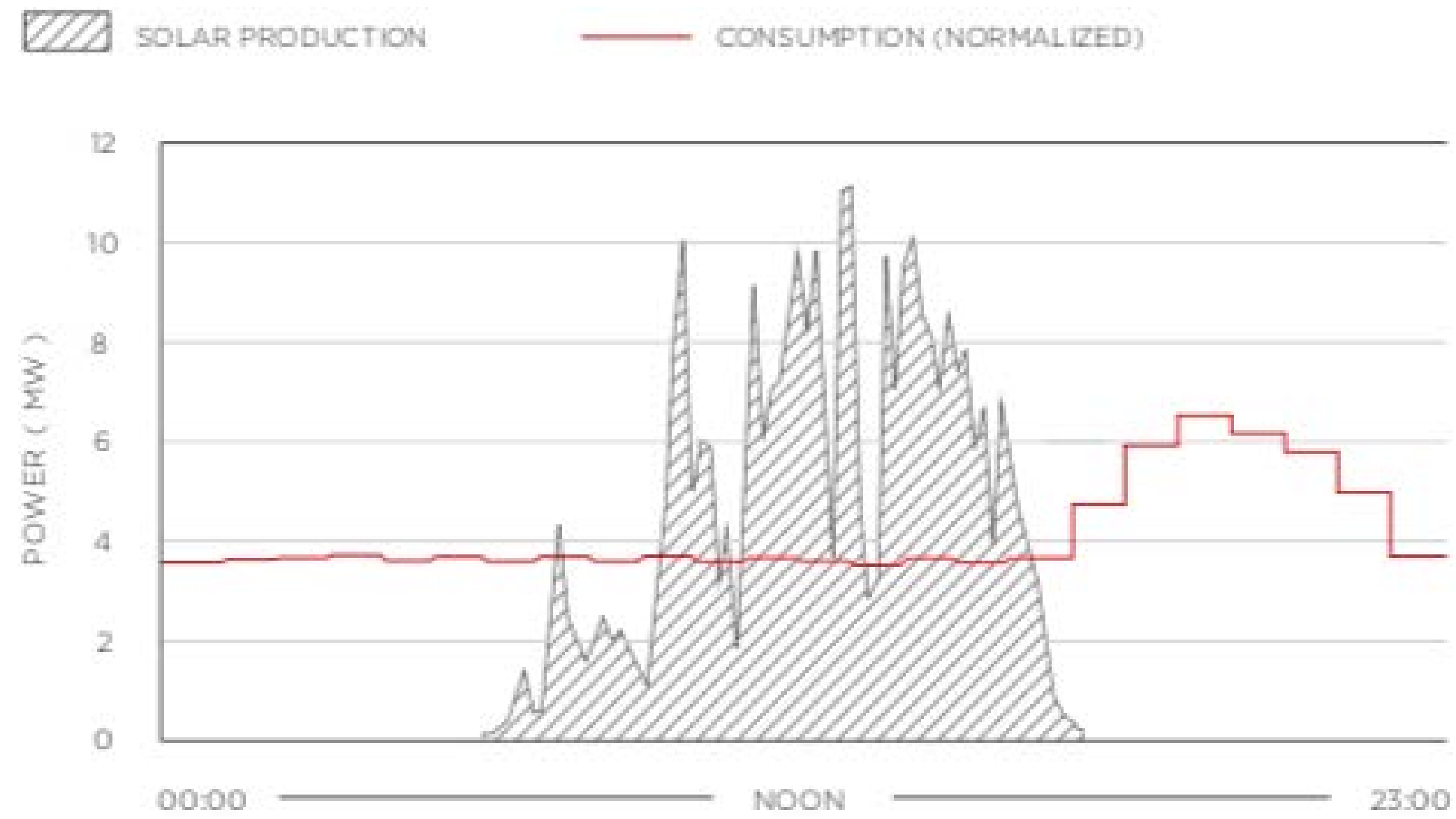
Kauai Island

13 MW | 52 MWh (13 MW Solar PV)

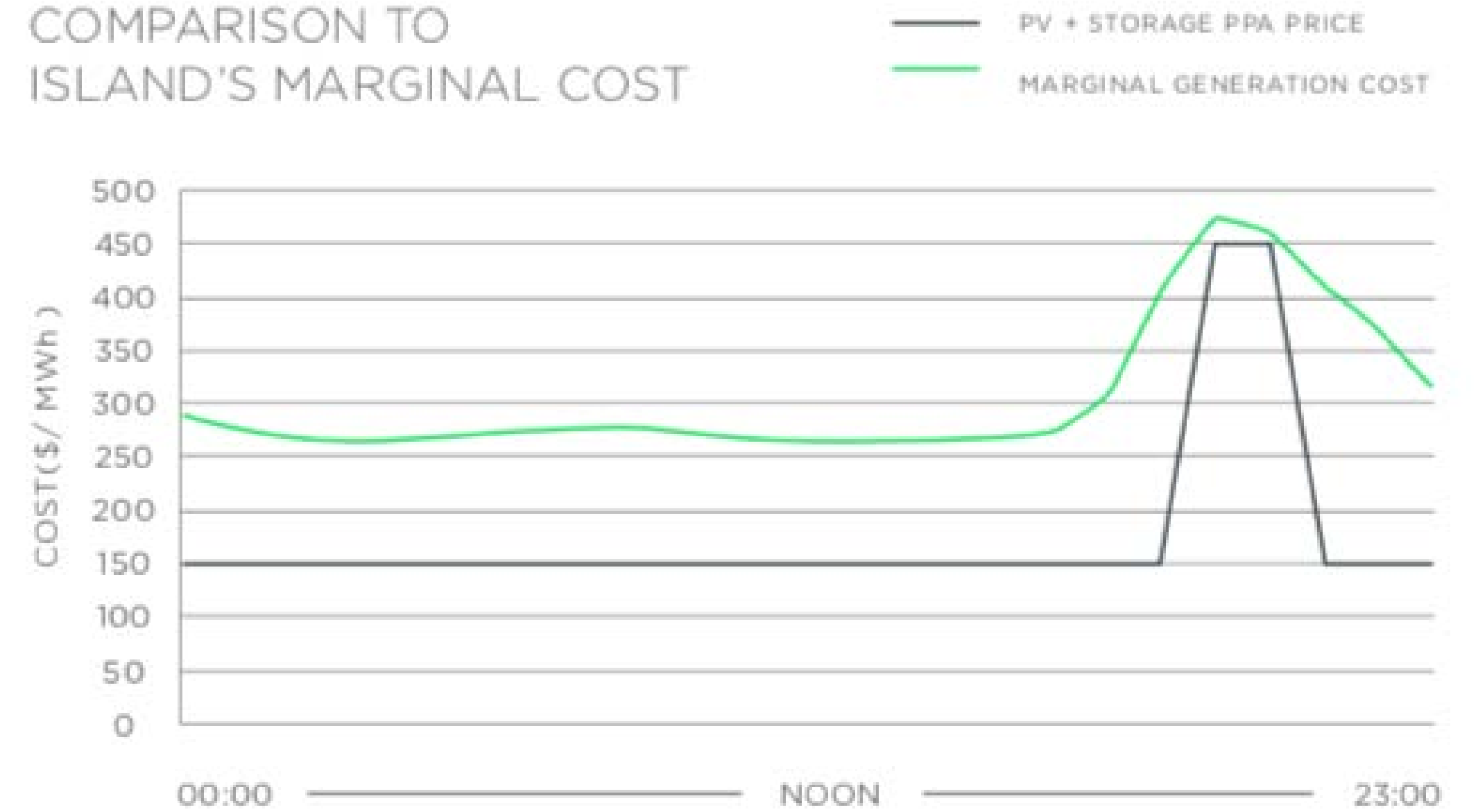
Commissioned 2017

Solar self-consumption & Load shifting

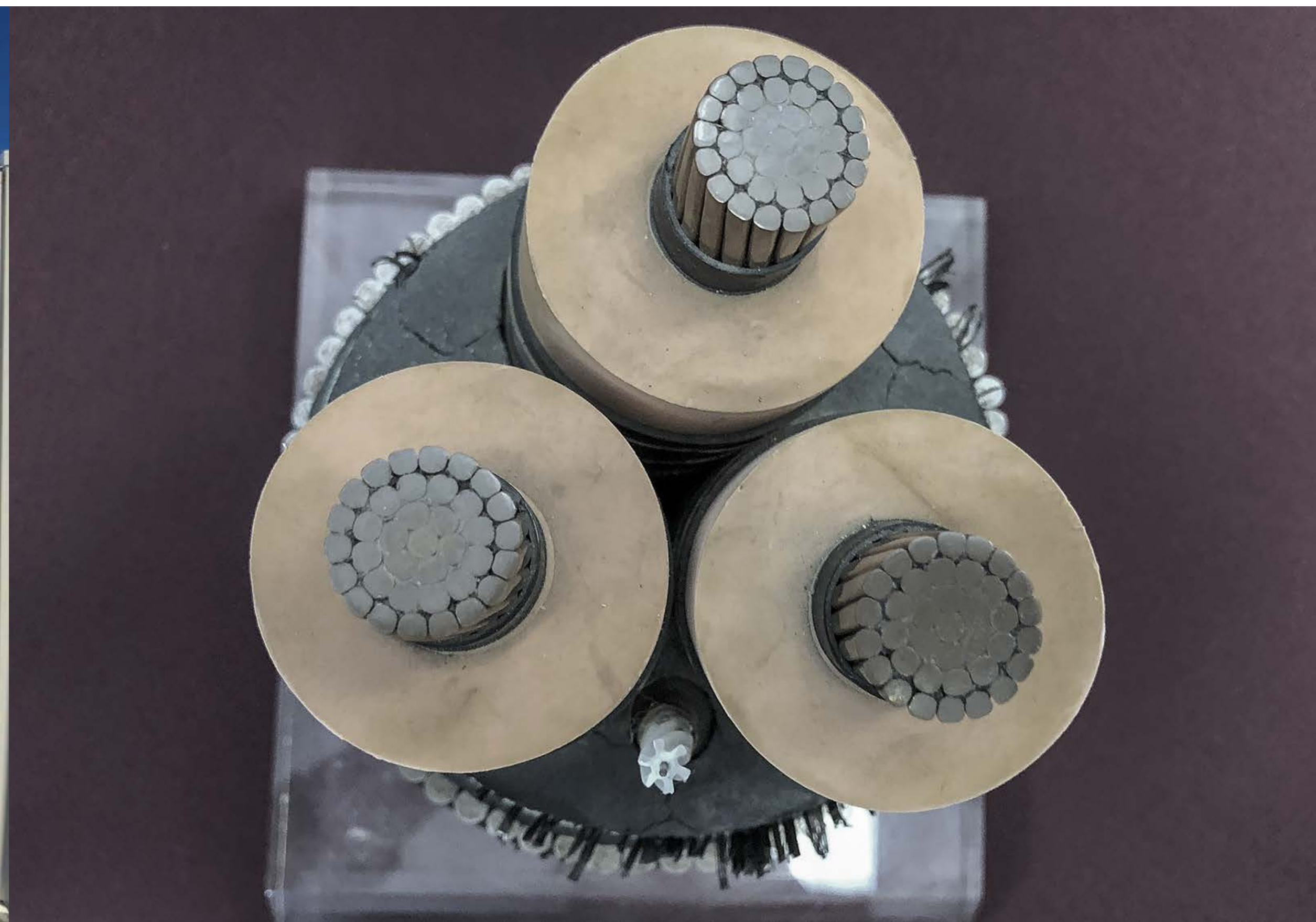
KAUAI ISLAND UTILITY COOPERATIVE (KIUC)



COMPARISON TO ISLAND'S MARGINAL COST



NANTUCKET- NEW ENGLAND



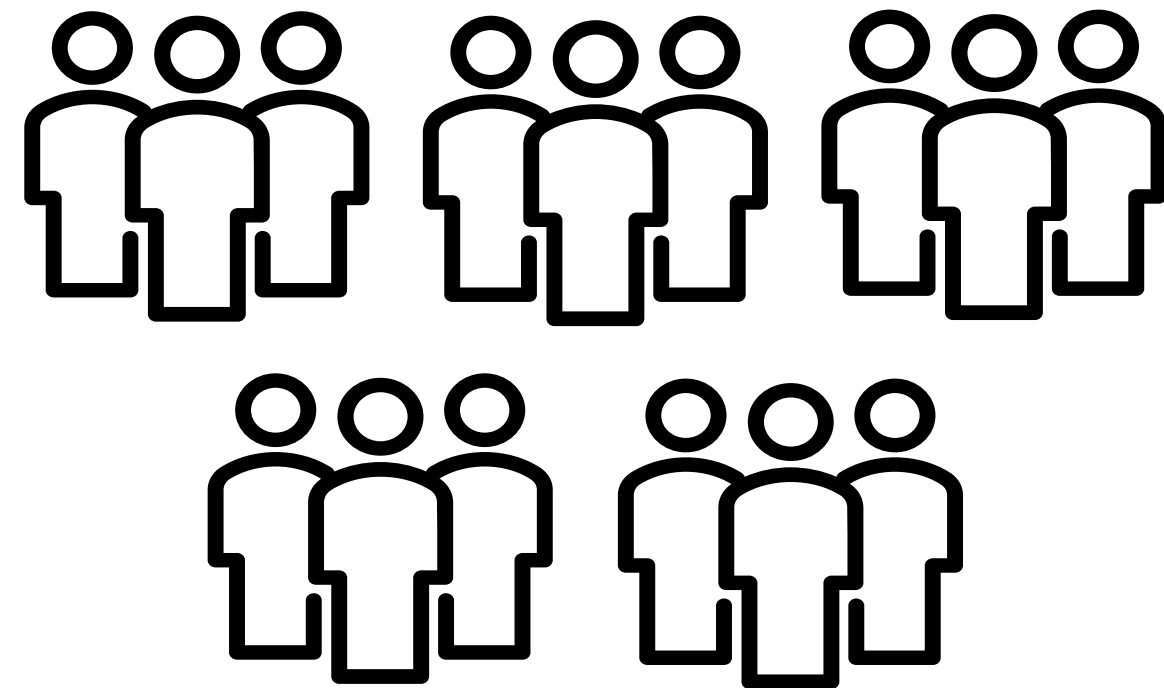
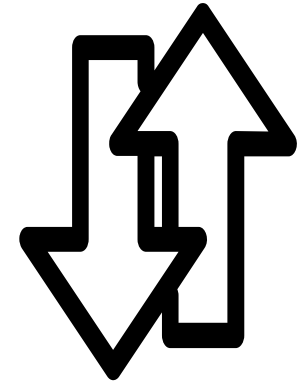
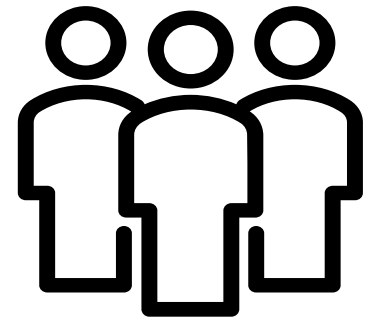
Nantucket

6 MW | 48 MWh

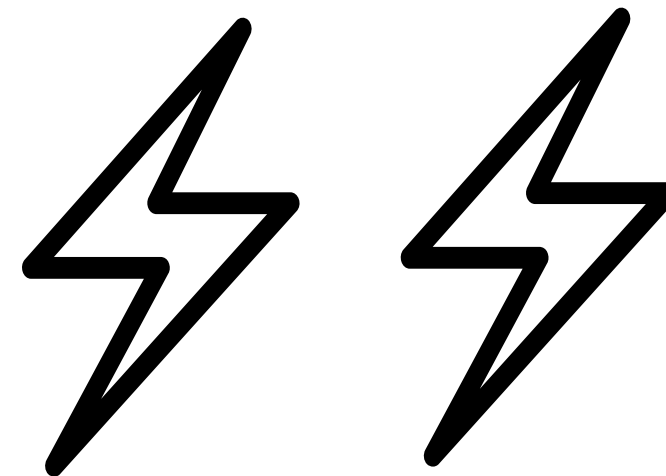
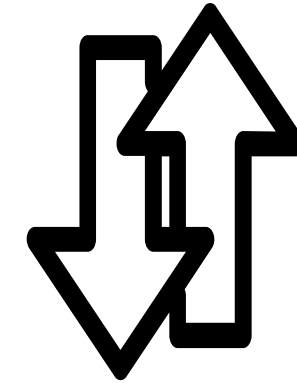
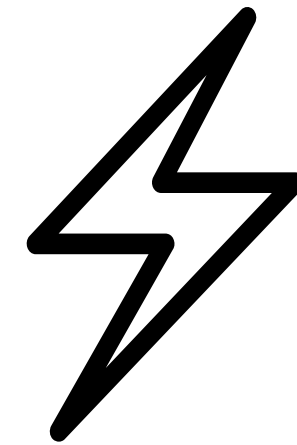
Commissioned 2019

T&D Upgrade Deferral

NANTUCKET- NEW ENGLAND

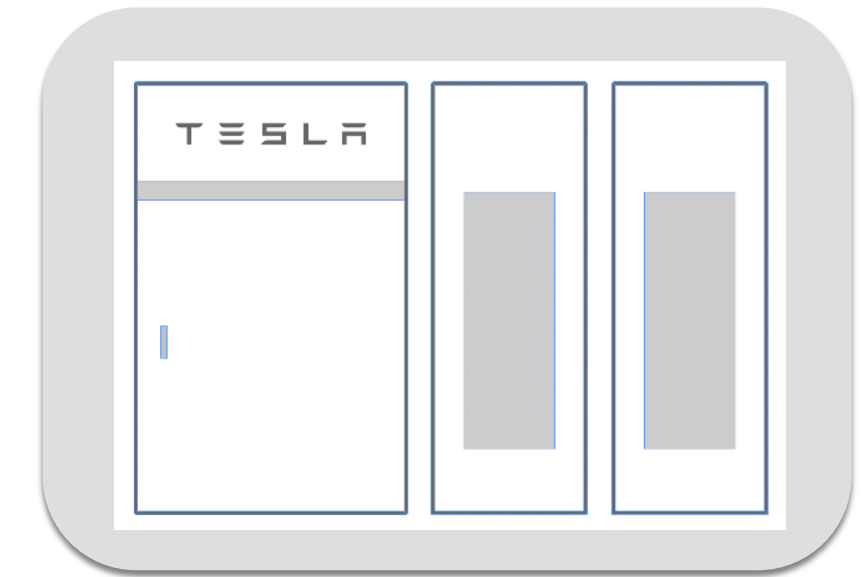
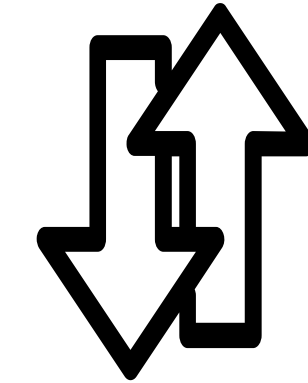


X 5 in Summer



25 MW --> 50 MW

A third subsea cable



200M USD → 81M USD

M E R C I

