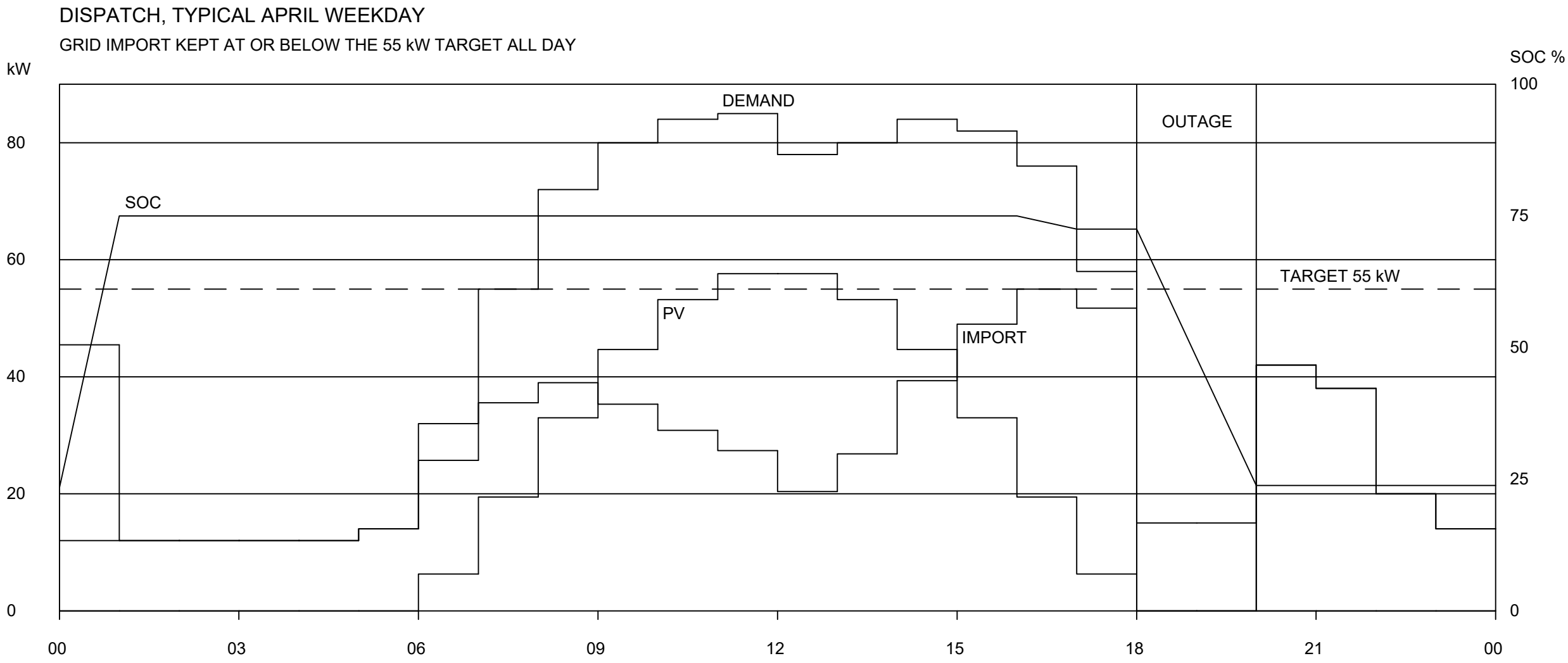


CONTROL STRATEGY

THE BATTERY HAS THREE JOBS. THE OUTAGE RESERVE OUTFRANKS THE OTHER TWO AT ALL TIMES.

PERIOD	ACTION	LIMIT
00:00 to 05:00	CHARGE FROM GRID AT THE OFF PEAK RATE	STOP AT 75 % SOC
06:00 to 18:00	CHARGE FROM PV SURPLUS	UP TO 100 % SOC
06:00 to 18:00	DISCHARGE ONLY TO HOLD GRID IMPORT DOWN	NOT BELOW 55 % SOC
18:00 to 20:00	GRID OFF. EPS BOARD ON PV AND BATTERY	DOWN TO 10 % SOC
20:00 to 06:00	DISCHARGE IF IMPORT WOULD EXCEED TARGET	DOWN TO 10 % SOC

GRID IMPORT TARGET 55 kW. ESSENTIAL BOARD 15 kW. THE 55 % FLOOR HOLDS 28.4 kWh BACK, WHICH IS 1.90 HOURS ON THE ESSENTIAL BOARD AGAINST A 2 HOUR OUTAGE, SO 96.8 % OF OUTAGE DEMAND IS MET OVER THE YEAR. A FULL BATTERY WOULD GIVE 3.79 HOURS. A HIGHER FLOOR WOULD COVER MORE OF THE OUTAGE AND LEAVE LESS FOR DAY TIME SHAVING.



PV IS GENERATION, DEMAND IS SITE DEMAND (ESSENTIAL BOARD ONLY DURING THE OUTAGE), IMPORT IS GRID IMPORT, SOC IS STATE OF CHARGE.

ANNUAL PERFORMANCE

	WITHOUT BATTERY	WITH BATTERY
PV GENERATED	116742 kWh	116742 kWh
SITE LOAD	383139 kWh	383139 kWh
GRID IMPORT, TOTAL	240188 kWh	250546 kWh
OF WHICH OFF PEAK CHARGING	NONE	12649 kWh
GRID IMPORT LESS BATTERY CHARGING	240188 kWh	237897 kWh
PV EXPORTED	4717 kWh	3996 kWh
ANNUAL GRID PEAK	75.2 kW	75.2 kW
HOURS OVER 55 kW	1078	695, DOWN 35.5 %
OUTAGE DEMAND MET	0 kWh, 0 %	10597 kWh, 96.8 %
BATTERY THROUGHPUT	NONE	12729 kWh, 223.9 FULL CYCLES
ROUND TRIP LOSS, BATTERY ONLY	NONE	641 kWh

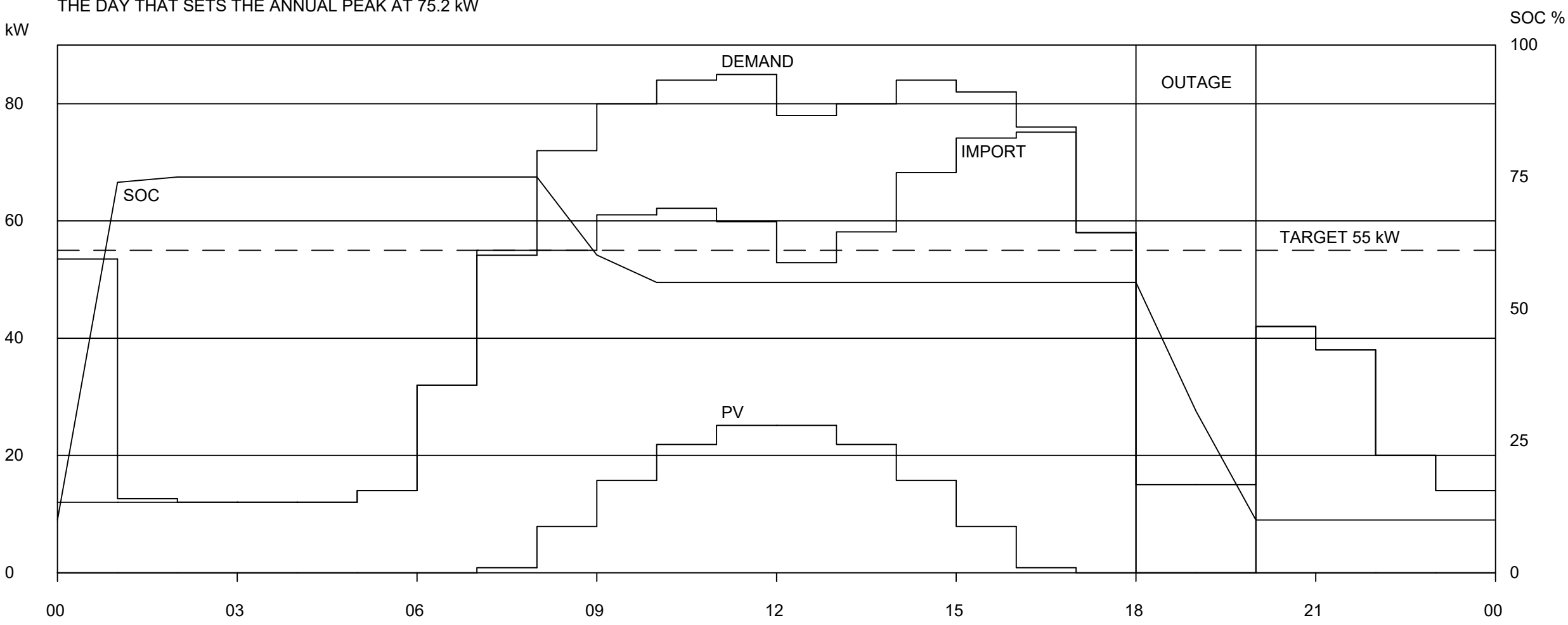
TOTAL IMPORT RISES BECAUSE OFF PEAK CHARGING IS ITSELF AN IMPORT. OF THE 12729 kWh THE BATTERY DELIVERS A YEAR, 10438 kWh CARRIES THE ESSENTIAL BOARD THROUGH THE OUTAGE (96.8 % OF OUTAGE DEMAND MET) AND 2291 kWh DISPLACES DAY TIME IMPORT OVER THE 55 kW TARGET.

BATTERY DESIGN NOTES

- BATTERY 63.18 kWh NOMINAL, 56.86 kWh USABLE AT 90 % DEPTH OF DISCHARGE. 9 No. FOXESS CQ7 LFP MODULES IN SERIES AT 518.4 V NOMINAL, ONE MASTER AND 8 SLAVES, ON BATTERY PORT 1 OF THE THREE THE INVERTER PROVIDES.
- POWER IS SET BY THE PORT, NOT BY THE CELLS. 80 A AT 518.4 V IS 41.5 kW CONTINUOUS, WHICH IS 0.66 C ON THIS STACK. THE CQ7 CAN GIVE 110 A FOR 60 s, BUT THE 80 A PORT CAPS IT, SO 41.5 kW IS ALSO THE PEAK. 240 A ACROSS ALL 3 PORTS.
- THE SITE LOAD IS 3.3 TIMES THE PV GENERATION, SO THERE IS ALMOST NO SURPLUS TO STORE. A BATTERY CHARGED ONLY FROM PV SURPLUS WOULD CYCLE ABOUT 13 TIMES A YEAR AND WOULD NOT BE WORTH FITTING. IT EARNS ITS PLACE BY BEING CHARGED OFF PEAK AND BY CARRYING THE OUTAGE, WHICH IS WHY THE CONTROL ABOVE IS BUILT THE WAY IT IS.
- THE ANNUAL GRID PEAK IS NOT REDUCED. IT FALLS ON A DECEMBER AFTERNOON WHEN THERE IS NO PV LEFT AND THE STATE OF CHARGE IS PINNED AT THE FLOOR THAT PROTECTS THE 18:00 OUTAGE. HOURS SPENT OVER THE TARGET DO FALL, BY 35.5 %. LOWERING THE ANNUAL MAXIMUM AS WELL WOULD NEED A SECOND CQ7 STACK ON PORT 2, OR AN AGREEMENT TO ACCEPT A SHORTER BACKUP THROUGH THE WINTER. THAT IS A COMMERCIAL DECISION, NOT AN ELECTRICAL ONE.
- 223.9 EQUIVALENT FULL CYCLES A YEAR. AT A TYPICAL LFP WARRANTY OF 6000 CYCLES TO 70 % THAT IS ABOUT 27 YEARS, JUST PAST THE 25 YEAR LIFE OF THE ARRAY, SO CALENDAR AGEING AND THE WARRANTY TERM WILL DECIDE REPLACEMENT.
- BATTERY PACK (DC) ROUND TRIP EFFICIENCY TAKEN AT 95 %, SPLIT EVENLY ACROSS CHARGE AND DISCHARGE, GIVING 641 kWh OF LOSS A YEAR. INVERTER CONVERSION LOSSES ON THE WAY IN AND OUT ARE NOT INCLUDED.
- THE LOAD PROFILE, THE DAILY OUTAGE WINDOW AND THE TARIFF PERIODS ARE DESIGN ASSUMPTIONS, NOT METERED DATA. THEY ARE DECLARED IN THE MODEL AND WOULD BE REPLACED WITH HALF HOURLY METER DATA BEFORE ANYTHING IS ORDERED.

DISPATCH, DECEMBER WEEKDAY

THE DAY THAT SETS THE ANNUAL PEAK AT 75.2 kW



OVERNIGHT CHARGE TARGET, SENSITIVITY

HOW FULL TO CHARGE OFF PEAK IS THE ONE SETTING THAT TRADES THE THREE JOBS AGAINST EACH OTHER.

CHARGE TO	OUTAGE MET	HOURS OVER 55 kW	HOURS CUT	PV STORED	CYCLES / YR
60 %	95.5 %	965	10.5 %	1106 kWh	193.5
75 %	96.8 %	695	35.5 %	720 kWh	223.9
90 %	97.4 %	503	53.3 %	305 kWh	247.2
100 %	97.7 %	390	63.8 %	0 kWh	260.2

75 % IS THE SETTING DRAWN. CHARGING FULLER SHAVES BETTER AND COVERS THE OUTAGE BETTER BUT LEAVES NO ROOM FOR THE MIDDAY PV SURPLUS. AT 100 % THE BATTERY TAKES NO PV AT ALL.

79 kWp ROOFTOP PV WITH 63 kWh BATTERY STORAGE

BATTERY CONTROL STRATEGY AND PERFORMANCE

DRAWN USAMA JAVED SITE I-10 INDUSTRIAL AREA, ISLAMABAD	SCALE NTS @ A1 DWG PV-03
REV P1 DATE 08.10.2026 CHK -- APP --	ISSUED FOR COMMENT